

FAA Safety

BRIEFING

May/June 2015

Your source for general aviation news and information

Aircraft Performance



Urban Air Legends

*Debunking Aircraft
Performance Myths, p. 10*

A Finesse for "Vitesse"

*Mastering the Maze of
V-Speeds, p. 14*

Bigger Bang Theory

*The Quest for More
Power, p. 26*



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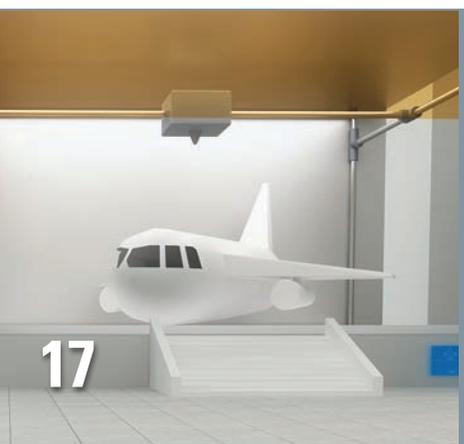
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The May/June 2015 issue of *FAA Safety Briefing* highlights aircraft performance. Articles focus on understanding the operating parameters of your aircraft as well as having realistic performance expectations during flight.

Cover photo courtesy of Cessna



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Performance Values

A big part of my job at the FAA, nowadays, is to lead the kind of cultural change that will make Flight Standards an efficient, agile, healthy, and high-performing organization. So when I meet with employees, I talk about three attributes I want to see embedded in our organizational culture: interdependence, critical thinking, and consistency.

As I was thinking about this performance-focused issue of *FAA Safety Briefing*, I realized that practicing these three behaviors can also help ensure high performance in your aviation activities.

Interdependence

Charles Lindbergh was nicknamed the Lone Eagle. For too many years, aviation unfortunately absorbed, even celebrated, that “go-it-alone” mentality. It took the better part of two decades, and far too many preventable accidents, for the FAA and industry to begin to embed the crew resource management (CRM) approach into the commercial aviation culture. We’ve been working for over ten years now to build a similar idea — Single Pilot Resource Management (SRM) — into GA culture.

Both CRM and SRM are great examples of interdependence, which means communicating broadly and recognizing that everyone has something to contribute. We tend to teach the CRM/SRM concepts in connection with actual flight operations, but interdependence is much broader than that. In the GA context, it should also mean “hangar flying” — talking to your fellow pilots to get ideas, share best practices, and give/receive advice. Great hangar flying includes holding yourself and your fellow hangar flyers accountable for improving skills, managing risk, and operating safely. You can also practice interdependence by attending FAASTeam safety seminars and participating in type clubs (a great resource). And, when it comes to any issue related to your aircraft, using interdependence to make and maintain connections with a good aviation maintenance technician (AMT) is worth gold.

Critical Thinking

For the past few years, there has also been an increased emphasis on what some call “higher order thinking skills.” I call it critical thinking. To me, that means using interdependence to help develop the necessary understanding of facts, desired outcomes, and possible solutions. It means asking the right

questions in the right way. It means making judgments based on each specific pattern of facts and on input from interdependent communications. It means managing risk.

In the GA flying context, critical thinking requires acquiring as much knowledge and skill as you possibly can about flying, both in general and in terms of your specific airplane and the type of flying you do. As the saying goes, a good pilot is always learning — and in aviation, there is always something more to learn.

While you are actually flying, critical thinking demands at least two things. First, it requires paying attention. Too many pilots have been lulled into the proverbial “fat, dumb, and happy” complacency that leaves them unprepared when something goes wrong. You need to be completely and constantly in the loop with what you and your airplane are doing — where you are going, and how it’s all going. Paying attention gives you the ability to quickly spot something that’s not quite right, such as an abnormal reading on a gauge.

Second, critical thinking requires asking a constant stream of questions. The classic one is “where would I go if the engine quit right now?” If you don’t know how to start framing your critical thinking questions, try using the aviate-navigate-communicate mantra. For example, use “aviate” to structure the “how-goes-it” questions about airspeed, altitude, and attitude. For “navigate,” don’t let the moving map lull you into inattention — constantly ask yourself where you are, and where you’re going (e.g., what’s the next waypoint). The “communicate” piece reminds us to ask questions about things like required radio calls or reports.

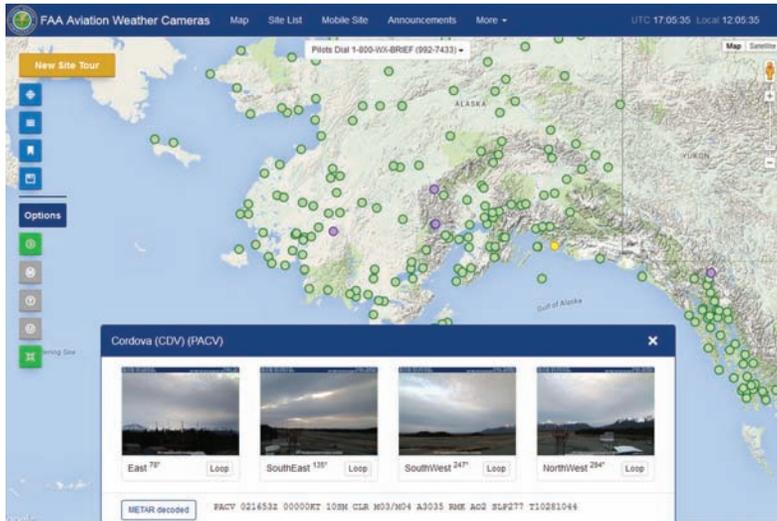
Consistency

When it comes to aviating, consistency is the key to the kind of high performance we should all be demanding of ourselves, and of our machines. Flying a stabilized approach is one example of consistency. Another is ensuring that you are constantly on the target airspeed, altitude, and attitude. Still another is striving for smooth handling of the controls, proper power settings, and appropriate use of on-board technology. And on the communication side, consistent use of approved terminology is certainly a mark of a high-performing pilot.

Now that you have some tips on stepping up your pilot performance game, on to the plane performance articles in this issue!



Alaska Weather Camera Program Fully Operational



Pilots now have access to a fully deployed Alaska Weather Camera Program to help determine when and where it's safe to fly. The program, which the FAA completed ahead of time and on budget, improves safety and efficiency by providing pilots with near real-time, visual weather information. It includes a recently updated website that enhances navigational planning on an interactive map with easily accessible images and other weather data products.

The pictures have been critical in helping pilots in Alaska make better safety decisions. The program also helps aircraft operators save fuel by eliminating situations where pilots take off only to find they have to return due to bad weather.

The cameras are positioned to view sky conditions around airports and air routes as well as in extreme mountain passes such as the Anaktuvuk Pass on Alaska's northern slope. The FAA started the program after determining that pilots operating under VFR would benefit from actual views of current weather conditions. Camera images are updated every 10 minutes and are disseminated to the public through the FAA's aviation camera website at <http://avcams.faa.gov>.

Change to Flight Instructor PTS

There was a small change to the Certificated Flight Instructor Practical Test Standards (PTS) in January 2015 that clarifies when a non-complex airplane is

required for the practical test. The change states that a complex aircraft is not required when adding an airplane class rating to an existing flight instructor certificate that already contains an airplane category and class rating. The FAA finds the requirements for the use of a complex airplane are not necessary when the applicant has already satisfactorily demonstrated the takeoff, landing, emergency, and other tasks contained within this PTS in a complex airplane. For example, an applicant seeking to add a single-engine rating to an existing flight instructor certificate that already contains an airplane multiengine category and class rating does not need to perform the practical test in a complex airplane.

You can access this update for flight instructors as well as the PTS for other airmen tests at www.faa.gov/training_testing/testing/test_standards.

Changes Coming to the Flight Service Program

Recognizing a shift in users' preferences for automated services, the FAA is changing its Flight Service operation to make it more efficient and reduce costs. The agency will continue to maintain the highest level of safety and none of these changes will affect core flight service safety functions such as search and rescue, emergency services, weather observation, NOTAM entry and dissemination, or pilot weather reports. Pilots are steadily shifting to automated and web-based tools to obtain services and Flight Service is already using this type of technology to eliminate underutilized and redundant services and reduce expenses. The FAA will phase in the changes to ease the transition for users.

For more information, including a Frequently Asked Question (FAQ) section, or to send comments, questions, and suggestions, please visit: www.faa.gov/go/flightservice.

Small UAS Rules Update

Last February, the FAA issued a Notice of Proposed Rulemaking (NPRM) to establish a framework of regulations that would allow routine use of certain small unmanned aircraft systems (UAS) in today's aviation system, while maintaining flexibility to accommodate future technological innovations. The proposal offers safety rules for small UAS (under 55 pounds) conducting non-recreational operations.

The rule would limit flights to daylight and visual-line-of-sight operations. It also addresses height restrictions, operator certification, optional use of a visual observer, aircraft registration and marking, and operational limits.

The proposed rule would require an operator to maintain visual line of sight of a small UAS. The rule would allow, but not require, an operator to work with a visual observer who would maintain constant visual contact with the aircraft. The operator would still need to be able to see the UAS with unaided vision (except for glasses). The NPRM also requested comments on whether the rules should permit operations beyond line of sight, and if so, what the appropriate limits should be.

Under the proposed rule, the person actually flying a small UAS would be an “operator.” An operator would have to be at least 17 years old, pass an aeronautical knowledge test and obtain an FAA UAS operator certificate. To maintain certification, the operator would have to pass the FAA knowledge tests every 24 months. A small UAS operator would not need any further private pilot certifications (i.e., a private pilot certificate or medical rating).

The proposed rule maintains the existing prohibition against operating in a careless or reckless manner. It also would bar an operator from allowing any object to be dropped from the UAS.

Operators would be responsible for ensuring an aircraft is safe before flying, but the FAA is not proposing that small UAS comply with current agency airworthiness standards or aircraft certification. For example, an operator would have to perform a preflight inspection that includes checking the communications link between the control station and the UAS. Small UAS with FAA-certificated components also could be subject to agency airworthiness directives.

The new rules would not apply to model aircraft. However, model aircraft operators must continue to satisfy all of the criteria specified in Sec. 336 of Public Law 112-95, including the stipulation that they be operated only for hobby or recreational purposes.

As of press time, the comment period for the NPRM was scheduled to close on April 24, 2015. For more information about UAS, go to www.faa.gov/uas.

New GA Survey Now Underway

The 37th annual General Aviation and Part 135 Activity Survey (GA Survey) for reporting on calendar year 2014 is now underway. As always, your participation is important. If you receive an invite to participate, please respond, even if you did not fly your aircraft in 2014.

The GA Survey is the FAA’s primary source of information about the size and activity of the gen-

Safety Enhancement Topics

May: Aircraft Performance – Knowing and understanding the limitations and operating parameters of your aircraft.



June: Transition Training – Understanding the need for transition training when moving on to a new or different type of aircraft.



Please visit www.faa.gov/news/safety_briefing for more information on these and other topics.



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eral aviation and on-demand Part 135 fleet. It helps provide useful data for all types of aircraft including rotorcraft, fixed-wing piston, turboprops, turbojets, gliders, hot air balloons, amateur-built, light-sport aircraft, experimental and non-experimental aircraft. The survey also covers many different aircraft operations, including general operating and flight rules (part 91), on-demand part 135 (air taxi, air tours, and non-scheduled commuter), and agricultural aircraft operations (Part 137). (To see more on how this information is used, check out the latest FAA Aerospace Forecast at <http://go.usa.gov/3CRAJ>.)

Please be assured that your responses are confidential. The information will be used only for statistical purposes and will not be released in any form that would reveal an individual participant. Tetra Tech is an independent research firm that conducts the GA Survey on behalf of the FAA. You can contact Tetra Tech with questions toll-free at 1-800-826-1797 or via email infoaviationsurvey@tetrattech.com.

New Flight Service Website Updates and Capabilities

Lockheed Martin Flight Service (www.1800wxbrief.com) has deployed another batch of great new capabilities and website updates. Below are the latest changes and newest features:

- The Departure Planning Tool has been enhanced to include indication of Adverse Conditions
- Coded Departure Routes are now available in the Plan a Route option
- NavLogs can be configured to use Hourly Burn Rates
- Auto generation of return Flight Plans
- Notifications of actual ATC routing for your IFR flights
- Adverse Condition Alerting System (ACAS) alerts for IFR flights are now sent up until your departure time
- Unmanned Aircraft Systems (UAS) operating areas (UOAs)

Flight Services has also unveiled a new video series on the online flight planning capabilities via the Pilot Portal. Training videos can also be accessed on YouTube at <http://bit.ly/1Ea37LN>.

New AME Guidance on Sleep Apnea

Obstructive sleep apnea (OSA) is a common disorder affecting at least 4 to 8 percent of the adult population and is increasingly recognized by the public. OSA is a disqualifying medical condition for an airman medical certificate under 14 CFR part 67 (Medical Standards and Certification) and poses a hazard to the safety of the National Airspace System (NAS) and to the health of airmen. The reason: OSA is a major cause of fatigue. The disorder also inhibits restorative sleep and can cause excessive daytime sleepiness, personality disturbances, cardiac dysrhythmias, myocardial infarction, stroke, sudden cardiac death, and cognitive impairments (decreased memory, attention, planning, problem-solving, and multi-tasking). As you can see, OSA is tied deeply to human performance.

Citing the significant medical and safety implications of OSA, the fact that OSA is underdiagnosed in the U.S. pilot population, and recommendations from the National Transportation Safety Board (NTSB), last year the Office of Aerospace Medicine (OAM) proposed new guidance to AMEs on screening for OSA. At that time, we proposed that AMEs would refer individuals with a BMI of 40 or higher to a sleep medicine specialist to determine the need for treatment. Following treatment, if indicated, these individuals would receive special issuance medical certification. While the proposal was designed to identify only the highest risk individuals, the announcement created significant concerns in the pilot community.

Responding to these concerns, OAM placed on hold the issuance of new medical guidance to AMEs with respect to screening for OSA. We have subsequently worked with the pilot community, AMEs, pilot advocacy organizations, and the aviation industry stakeholders to incorporate their ideas for a more inclusive approach for pilots that would also address the safety concerns of the FAA and the NTSB.

The new screening guidance gives AMEs more flexibility in addressing pilots at risk for OSA. There will be no deferral of a pilot's medical certificate based on BMI alone. The risk of OSA will be determined by an integrated assessment of history, symptoms, and physical/clinical findings. Some of the factors your AME will be on the lookout for that signal an increased risk of OSA include: history of

hypertension that requires more than two medications for control, Type 2 diabetes, atrial fibrillation, congestive heart failure, or stroke. Other symptoms your AME should ask about that would suggest an increased risk of OSA include: snoring, daytime sleepiness, complaints of awakening with the sensation of gasping or choking, witnessed apneas (cessation of breathing), morning headaches, decreased concentration, memory loss or irritability. Physical/clinical findings that would suggest to your AME an increased risk of OSA include: Obesity (high BMI), increased neck circumference, enlarged tonsils and nasal abnormalities such as polyps or deviation of the nasal septum.

I believe this new OSA screening guidance will significantly improve upon the safety of the NAS. A significant secondary benefit will be improved pilot health and career longevity. Also, the changes in the certification process substantially expand physician screening options to reduce the frequency and costs of unnecessary evaluations and testing. Finally, one of the most significant benefits is the result of the issuance of a regular medical certificate for the airmen determined by the AME to be at significant risk for OSA and referred for further evaluation. This saves months of flying compared to the current policy that requires deferral.

Overall, aviation safety and pilot health will be enhanced while reducing the financial burdens and disincentives for obtaining OSA evaluation and treatment. With this new policy, AME and pilot awareness of the dangers of OSA will improve and the benefits of treatment will continue to grow.

James Fraser received a B.A., M.D., and M.P.H. from the University of Oklahoma. He completed a thirty year Navy career and retired as a Captain (O6) in January 2004. He is certified in the specialties of Preventive Medicine (Aerospace Medicine) and Family Practice. He is a Fellow of the Aerospace Medical Association and the American Academy of Family Practice.

Learn More

OSA Screening Guidance Video for AMEs

www.faa.gov/tv/?mediaid=1029

FAA Fact Sheet on Sleep Apnea

www.faa.gov/news/fact_sheets/news_story.cfm?newsid=18156

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Ask Medical Certification

COURTNEY SCOTT, D.O.
MANAGER, AEROSPACE MEDICAL
CERTIFICATION DIVISION

Q1. I am a sport pilot who would like to become a private pilot. I have “white coat hypertension,” as well as a racing pulse in a Dr.’s office. I also have occasional paroxysmal tachycardia which, aside from feeling an odd and rapid heartbeat sensation, is asymptomatic. EKGs are normal; no associated atrial fibrillation. My primary care doctor, a cardiologist, looks at home readings for pulse and blood pressure and is not concerned about any of these issues. What should I expect before I can get a third class medical?

A1. The Aerospace Medicine Certification Division would need to review your medical records and testing that has been done to evaluate your hypertension and paroxysmal tachycardia. We would need to rule out any underlying structural or ischemic cardiac conditions that could be associated with these, especially the tachycardia. If these are satisfactory, special issuance will be granted.

Q2. I was diagnosed with OCD with a single episode of anxiety/depression. I have been flying for the airlines now for 10 years and I am concerned I won’t be able to fly again. I have been taking Lexapro® for six months and I have recently put in a request for a special issuance with the FAA. I was wondering what my options may look like concerning a medical.

A2. The medication, escitalopram (Lexapro®), is now acceptable for special issuance if certain conditions are met. The Federal Air Surgeon’s staff would need to review all of your treatment records. You would also need to provide some neurocognitive testing and documentation from an Independent Medical Sponsor. The good news is that you have already been on the medication long enough for this

process to begin. We already have a number of pilots on this special issuance program, and they are doing very well.

Q3. I have a special issuance first class medical certificate due to what has been diagnosed as asymptomatic leukopenia (NOT leukemia!). My primary physician, my AME, and the folks at AMAS all think that my “condition” is absolutely normal for me and is nothing to worry about. I wonder if it is possible to obtain a normal first class medical certificate without the special issuance, and what steps exactly I must follow to make this happen.

A3. Although we would need to see the specifics, there is a very good chance we would concur with your primary care physician and AME. Have your AME request that the Aerospace Medicine Certification Division evaluate your condition as a normal variant.

Q4. I have e-mailed you before at the middle of my Chemo treatment. I have been off treatment for a year and did in November receive a Special Issuance on my second class medical. Rituxan is approved by the FAA, but Cladribine is not. It was stated that I could request the FAA evaluate Cladribine for allowance. How do I go about that? Is that something you can do? I had Non-Hodgkin’s Group B slow growing Follicular Lymphoma.

A4. I will ask for the appropriate group to evaluate the safety profile for Cladribine in aeromedical use.

Send your questions to SafetyBriefing@faa.gov. We’ll forward them to the Aerospace Medical Certification Division without your name and publish the answer in an upcoming issue.

Fly with us on Twitter

 @FAASafetyBrief





Image courtesy of Arsenal of Democracy Flyover

ARSENAL *of* DEMOCRACY

Celebrating VE Day in a Grand (and Safe!) Fashion

PAUL CIANCIOLO

On May 8, 2015, perhaps one of the largest, most diverse formations of World War II aircraft ever assembled is scheduled to take part in a narrated flyover of the National WWII Memorial and National Mall in Washington, D.C., as part of the 70th anniversary of Victory in Europe (VE) Day. The historically sequenced warbird formations represent the war's major battles from Pearl Harbor to D-Day to the final air assault on Japan.

"The warbirds played a tremendous part in our success in the war, and will forever be a symbol of our country's patriotism and tenacity when fighting for freedom," notes former President George H.W. Bush on the nonprofit Arsenal of Democracy's website, of which he is honorary co-chair. "As a former Avenger pilot, I am pleased to be part of this tribute alongside my fellow veterans."

The "Arsenal of Democracy" in World War II was a slogan used by President Franklin D. Roosevelt, in a radio broadcast delivered December 29, 1940. Roosevelt promised to help the United Kingdom fight Nazi Germany by giving them military supplies while the United States stayed out of the actual fighting. The announcement was made a year before the attack on Pearl Harbor, at a time when Germany had occupied much of Europe and threatened Britain. "The great arsenal of democracy" came to specifically reference America and its industrial machine, as the primary military supplier for the Allied war effort.

Vintage military aircraft are being provided by multiple organizations and individuals whose mission is to preserve these historic artifacts in flying condition. Among the aircraft expected is the only airworthy B-29 *Superfortress*, which is the same aircraft type that dropped the atomic bombs on Japan to end the war. Other aircraft include the P-40 *Warhawk*, P-39 *Aerocobra*, P-38 *Lightning*, P-51 *Mustang*, P-47 *Thunderbolt*, FG-1D *Corsair*, B-25 *Mitchell*, B-17 *Flying Fortress*, and many others.

Flying more than 70 airplanes with standard, limited, or experimental certificates over national landmarks inside restricted airspace posed some significant challenges to mitigate. The Commemorative Air Force (CAF) was granted three exemptions from Title 14 Code of Federal Regulations (14 CFR) section 91.319(c), which states that no person may operate an experimental type certificated aircraft over a densely populated area or in a congested airway.

"Our goal was to make sure the flyover could be conducted safely," explains Jim Viola, manager of the FAA's General Aviation and Commercial Division. "We had to assess and mitigate the risks, which included focusing on the specific route over the Potomac River to minimize exposure to people and property on the ground."

The FAA's General Aviation and Commercial Division, part of the Flight Standards Service, worked with both the Washington and Baltimore Flight Standard District Offices and used a risk-based decision making process to allow this his-



photo by Luigino Caliaro

The FG-1D was a version of the popular Marine Corps/Navy F4U Corsair produced by the Goodyear Company



Photo by Raymond Stinchcomb

A P-51 in formation with a B-25 and B-17



photo by Scott Slocum

The P-51 and B-29 both played major roles in the later phases of the war.

toric undertaking.

Additionally, the FAA's Air Traffic Organization worked with all of the parties involved to be able to minimize overflight of people and property on the surface, offer a structure for ingress and egress to the display area, coordinate the hold on departures out of National Airport (DCA), and provide risk-mitigating strategies for all participating aircraft.

"It is a huge task to coordinate a flyover of this magnitude in the Washington, D.C., airspace. We are very appreciative of the close coordination and support we have received to date from federal entities such as the FAA, TSA, Secret Service, U.S. National Park Service, and Capitol Police, just to name a few," said Pete Bunce, president and CEO of the General Aviation Manufacturers Association.

The participants and the FAA decided on the specific VFR flight path down the Potomac River, which was already in everyday use and familiar to ATC specialists for arrivals and departures from Reagan National Airport (DCA) and avoids densely

populated areas. While on the display route over the National Mall area, aircraft can maneuver to a non-congested area within 30 seconds if required for an emergency landing. The route also minimizes conflict with the air carrier traffic inside Dulles Class B airspace.

The minimum safe altitudes for each aircraft were also evaluated. For example, a P-40 *Warhawk* has a 4.5 to 1 glide ratio but a P-51 *Mustang* has 12 to 1 glide ration, so aircraft specific minimum altitudes were determined to be able to avoid people and property in an emergency.

Formation training and currency of pilots was also required. Crew training and standardization was based on CAFs Living History Flight Experience exemption.

"We are glad to be part of this historic event and fulfil our responsibility ensuring public safety," said Viola.

For more information about the flyover and Arsenal of Democracy, go to www.ww2flyover.org. For more information on petitioning for exemptions, go to <http://1.usa.gov/1BKhsuY>. 

Paul Cianciolo is an assistant editor and the social media lead for FAA Safety Briefing. He is a U.S. Air Force veteran, and a rated aircrew member and search and rescue team leader with the Civil Air Patrol.



Photo by Raymond G. Stinchcomb

URBAN “AIR” LEGENDS

Debunking Aircraft Performance Myths



Photo by James Williams

"As long as I stay in the yellow arc, my airplane can handle a little rough air."

"It's only a tiny bit of frost on the wings. We can still take off."

"If you inadvertently spin, just let go of the controls."

"We're below V_A , I'm safe to make whatever control inputs I need."

Any of these sound familiar? Most general aviation pilots will admit to hearing at least one (or more) of these common aircraft performance myths during their flying careers. These myths can originate for any number of reasons: a lack of knowledge, training miscues, uncorrected bad habits, laziness, and yes, the infamous pilot bravado. While helping you dial down your machismo is a bit out of scope for this article, we can, however, provide some tips to help debunk some of the more popular urban “air” legends out there.

We Should Be Able to Clear Those Trees — No Problem

In the May/June 2009 *FAA Safety Briefing*, aerospace engineer David Schwartz relayed a stirring personal account of a “run-in” he and his plane had with a tree at the end of a runway. Spoiler alert: The tree won. Unfortunately, they usually do. By sharing his tale with fellow pilots, Schwartz was able to leverage this ego-bruising moment to highlight his mistakes and point out some key takeoff performance metrics that are often underestimated or taken for granted.

The tree that had Schwartz’s number that day was a modest ten feet high. As pilots sometimes do, Schwartz admits he was focused more on takeoff distance than on what obstacles were lurking at the end of runway. With the relatively flat climb angles of most small airplanes, that’s an important element not to overlook. “Even though ‘the book’ said it would be tight, I thought that I could make it because the trees weren’t that tall,” said Schwartz.

So how exactly are we supposed to measure obstacles at the end of a runway? There are a few good resources that can help including the Airport/Facility Directory, instrument approach plates, or even asking airport personnel or fellow flyers. In most cases it’s probably easier (and safer!) to err on the side of caution and be conservative with your estimates. Here’s a simple method Schwartz suggests using to get a ballpark idea on the height of a tree:

- Fold a piece of paper into a 45-degree triangle.
- Sight along the diagonal edge as you walk toward the tree.
- When you see the tree top along the diagonal edge of the paper, the tree height is equal to your distance from it, plus your height.

After you know the height of your obstacle, it’s time to make sure you can clear it. You’ll want to check your Pilot’s Operating Handbook (POH)/Aircraft Flight Manual (AFM) for the difference between the ground-run distance and the takeoff over a 50-foot obstacle distance. Here’s the example Schwartz used: A Piper *Super Cub* POH has a published 200-foot ground roll, with a total takeoff distance of 500 feet to get over a 50-foot obstacle. So,

it takes 300 feet from liftoff to clear the obstacle. This means that over a 100-foot obstacle, you would need about 800 feet (500 feet for the first 50 feet, plus an additional 300 for the next 50).

Keep in mind that certain runway conditions like grass, soft ground, or snow will require a correction factor, generally on the order of 15 percent. Check what's appropriate for your specific aircraft. Even if a runway seems dry, beware of hidden puddles that could hamper your acceleration. And it's not just what's on the runway that can hurt your performance. In the colder months, be sure your aircraft is free from any contaminants. Even the slightest bit of frost, ice, or snow can reduce lift by 30 percent and increase drag by 40 percent.

Wind is another factor sometimes misunderstood when calculating takeoff performance. Tailwinds on takeoff are bad of course, but knowing just how bad is critical. If your airplane's POH/AFM doesn't have tailwind correction factors, Schwartz suggests that for every 10 percent of the takeoff speed, a tailwind will increase the ground run by about 21 percent. Then again, it's probably best to just not takeoff with a tailwind.

Less obvious is the impact of crosswinds which can rob performance by introducing additional drag via corrective control surface inputs and tires. And while headwinds generally improve takeoff performance, don't be overly confident of that extra boost. They could shift or drop off rapidly after becoming airborne.

Remember, the results you get from takeoff and landing calculations are never an absolute. It's best to always assume it'll be longer than you calculate. A good rule of thumb is to add 50 percent to your numbers.

Put a Spin On It

Pilots are often unaware of, or do not fully appreciate what goes into the certification of light airplanes with regard to stall and spin behavior. Many might think that by the time designers and lawyers get done with a particular design, the published operating envelope is a lot smaller than it actually is.

But nothing could be farther from the truth! It is in the best interest of airplane manufacturers to provide their customers with as much operating envelope as can be squeezed out of their designs; consequently, there may not be as much "cushion" as pilots might think.

NASA spin tests of a Cessna 172, for example, revealed a steadily increasing probability of success-



Photo by James Williams

With the relatively flat climb angles of most small airplanes, it's important to not overlook the height of obstacles at the end of a runway.

ful spin entries (given pro-spin inputs) as the center of gravity moved from the forward to the aft limit. Moreover, test pilots encountered unrecoverable spins when the aircraft was loaded just five percent beyond the manufacturer's aft limit.

While we're on the subject, a placard prohibiting intentional spins means an airplane has only demonstrated recovery from a one-turn (or three-second) spin within one additional turn. Beyond the first turn (or three seconds), spin recovery may be impossible; the pilot becomes a test pilot at that point. And even in airplanes approved for intentional spins, if you're not following the right procedures, or if you operate outside the weight and CG envelope (both of which are not that hard to do) you may not be able to recover. There is also no certification requirement for spin-certified airplanes to demonstrate recovery from aggravated or flat spins.

As harmless as it may seem, it can be dangerous to infer one airplane's stall/spin behavior based on similarities in appearance with another airplane. This is especially true if the airplane has been modified in any way, or is experimental/amateur-built. As far as stall/spin behavior is concerned, looks can be deceiving, even deadly: avoid the temptation to assume that the reported stall/spin behavior of a similar airplane can be applied to the one you fly.

Another spin myth worth pointing out is that simply letting go of the controls during an inadvertent spin will help you to recover. In addition to this being a completely unnatural reaction to such an event, it can have inconsistent results. Early release of the controls during a spin might work in some aircraft, but letting go too late or under some different conditions may result in the inability to recover.

Pilots are often unaware of, or do not fully appreciate what goes into the certification of light airplanes with regard to stall and spin behavior.



Even the slightest bit of frost, ice, or snow can reduce lift by 30 percent and increase drag by 40 percent.

Photo by H. Dean Chamberlain

Furthermore, most inadvertent spins occur at pattern altitude. Letting go to recover then may result in more altitude loss than you would with making a prompt and properly exercised recovery maneuver.

Watch This!

Those are the two words you probably never want to hear in an airplane. They usually precede a series of “stupid pilot tricks” that can quickly bring an aircraft to the brink of its breaking point. As we stated with spins earlier, there’s a common misconception among pilots that manufacturers build in plenty of cushion in terms of load limits, and that what’s in the POH/AFM is probably just a conservative estimate.

One operating limitation in particular that’s misunderstood is maneuvering speed (V_A). A common and unfortunate pattern that seems to have pervaded many a pilot’s thinking on V_A is that they can “yank and bank” on the controls with impunity. Not so.

A wake-up call to the pilot community on the error of this thinking occurred shortly after American Airlines Flight 587 crashed into Belle Harbor, a neighborhood just outside of JFK airport in Queens. The NTSB concluded that the crash, which killed 265 people, was due to the Airbus A300 co-pilot’s over-use of the rudder to counter wake turbulence.

“The American 587 accident was a landmark case for ‘paradigm shifting without a clutch’ for almost all pilots,” says FAA Aerospace Engineer Peter Rouse. “We have been trained that V_A was the speed in which there were no limits on the number of times a full, abrupt control input could be accomplished.”

To help clarify the meaning of V_A and caution pilots about what to avoid, the FAA published Special Airworthiness Information Bulletin (SAIB) CE-11-17 in 2011. The SAIB defines V_A as the following:

The design maneuvering speed (V_A) is the speed below which you can move a single flight control, one time, to its full deflection, for one axis of airplane rotation only (pitch, roll or yaw), in smooth air, without risk of damage to the airplane.

Even though the accident discussed above is a part 25 airplane, V_A is applicable to part 23, CAR 3, and light-sport airplanes. Also, even though experimental airplanes may not have a published V_A , they will still have some maximum maneuvering speed associated with the maximum structural design loads.

The SAIB goes on to recommend that when maneuvering at or below V_A , pilots should not apply a full deflection of a control, followed immediately by a full deflection in the opposite direction, or apply full multiple control inputs simultaneously; i.e., pitch, roll and yaw simultaneously, or in any combination thereof. The regulations do not require the manufacturers to make airplanes strong enough to withstand those types of forces.

Though it seems counterintuitive, it’s important to note that V_A decreases when your total aircraft weight decreases. For example, V_A may be 100 knots when an airplane is heavily loaded, but only 90 knots when the load is light. You have Newton’s Second Law of Motion ($F=ma$) to thank for that.

A final tip on maneuvering in flight: the yellow arc on your airspeed indicator is for *smooth air only*. While you may feel your airplane is sturdy enough to handle a bit of rough air in the yellow, know that you’re going beyond what any flight test pilot has experienced on your aircraft. It may not cause your airplane to break apart, but it can subject it to forces that lead to accelerated fatigue.

Myths-busted!

Hopefully this article gave you some helpful information to think about with regard to some of the popular “tall tales” of aviation. The key to many of these myths is to understand where a particular performance limit comes from in the first place. By better understanding the context and background with why and how certain behaviors exist, you’ll be well on your way to making safer decisions. ✈️

Tom Hoffmann is the managing editor of FAA Safety Briefing. He is a commercial pilot and holds an A&P certificate. Contributing to this article was Rich Stowell, a Master Flight Instructor, active FAAS Team representative, aviation author, and veteran spin expert with over 33,000 spins performed.

Learn More

FAA Special Airworthiness Information Bulletin CE-11-17
<http://go.usa.gov/3rMNP>

Part 23 Rewrite *Update*

Before the Small Airplane Revitalization Act of 2013 was signed into law, the Federal Aviation Administration (FAA) typically reviewed 14 CFR part 23 about once a decade. However, with the influx of new and novel technologies to the aviation industry (such as angle-of-attack sensors, two-axis autopilots, and other safety-enhancing systems), and in the FAA's quest to apply risk-based decision making to our certification activities, a change was certainly due.

Enter the Part 23 Reorganization Aviation Rulemaking Committee.

The Committee was chartered in August 2011 and their recommendations provided the foundation for the bill and the FAA's part 23 rulemaking project, or what is better known as the "part 23 rewrite." Their original objective was to review the various operations and airworthiness processes currently in place through the airplane's service life and identify process improvements — an arduous task to say the least. In June 2013, the committee published recommendations on regulatory structures, alterations and modifications, and type and product certification.

The FAA's proposed rule will affect engineering standards for part 23 airplanes that are less than 19,000 pounds and have fewer than 19 seats. The new performance-based regulations will pave the way for technological advancements and establish high-level safety requirements. This includes adopting consensus-based methods of compliance developed in cooperation with the aviation industry and other interested safety agencies.

So, What is Happening Now?

This rewrite is a significant rulemaking project and a priority for the FAA; however incorporating all of the findings in a way that is fair, can be applied and enforced, and does not have an adverse effect on aviation safety or aircraft airworthiness is labor-intensive. The new rule will touch many different aspects of aviation. For instance, the airplane performance requirements in part 23 have some overlap with the operational flight rules. The engineer responsible for the flight performance section must coordinate with the aviation safety inspectors to make sure that the part 23 changes dovetail into parts 91 and 135.

The next step in the project is to release the proposed rule to the public for comment in what is called a "notice of proposed rulemaking." The notice will include what the rule intends to change. After the FAA addresses any relevant comments, the proposal will move to the "final rule" stage, which will dictate the new, revised, or removed requirements and their effective date. It will also identify the substantive issues raised by the public and will state how the FAA responded to those concerns.

The process to draft this new rule involves a host of dedicated individuals from multiple divisions across the FAA. Through their hard work and dedication, the part 23 rewrite will ensure the future of general aviation while maintaining the safety and integrity of the most efficient aerospace system in the world.

To read the Reorganization Aviation Rulemaking Committee's full report, visit go.usa.gov/33Eeh. 



A Finesse for



“VITESSE”

Mastering the Maze of V-speeds

SUSAN PARSON

Photo by James Williams

Maverick: *I feel the need...*
Maverick/Goose: *...the need for speed!*
— *Top Gun (1986)*

Where would our jargon be without *Top Gun*? Although it's not a great idea to emulate every Maverick move (e.g., buzzing the tower never ends well), the need for speed is both a thrill and a necessity when it comes to aviation. That's why clever airspeed-related sayings abound. My favorites include “airspeed is life,” “maintain thy airspeed lest the ground rise up and smite thee,” and of course Chuck Yeager's advice to make sure you “never run out of altitude, airspeed, and ideas at the same time.”

That's also why instructors and evaluators make such a big deal of memorizing your V-speeds. In Title 14 Code of Federal Regulations (14 CFR) part 1, there are 35 defined V-speeds. A quick Google search on the term brings up an absolutely dizzying array of additional $V_{\text{subscript}}$ options. And then there are the V-speed definitions in 14 CFR part 23 and part 25, which are used for aircraft certification and design (though not operational use).

So where to start and what do you really need to know? Obviously there's no need to memorize Mach-number V-speeds if your flying (like mine) is confined to piston-powered planes, but it's important to know — and even more important to *understand* — the major V-speeds for the make(s) and model(s) that you do fly.

“V” is for ...?

First, a fun fact about the term itself: do you know what “V” stands for? Most native speakers of English assume that V is for velocity, and that mostly works. To be precise, though, the word velocity

means “speed in a particular direction.” Technically, V stands for “vitesse,” another aviation term borrowed from the French; “vitesse” being the French word for “speed” or “rate.”

Now for the definition: V-speeds are the airspeeds defined for specific maneuvers in specific aircraft at specific configurations (e.g., flaps, gear). The actual speeds represented by the V-designator are true airspeeds (TAS) expressed as indicated airspeeds (IAS), which allows the pilot to read them directly from the airspeed indicator. To assist the pilot in this task, the airspeed indicator in most general aviation aircraft has color-coded arcs and lines that demarcate some (but not all) of the most commonly used and most safety-critical airspeeds.

How are V-speeds determined? Aircraft designers and manufacturers perform flight tests to help determine aircraft performance and limitations. They use the resulting flight test data to help determine specific best speeds for safe operation of the aircraft. Once the designers and manufacturers have done their part, government flight inspectors verify the data during type-certification testing.

Which Ones Do I Really Have to Know?

We've already noted that 14 CFR part 1 includes definitions for 35 separate V-speeds (see sidebar). You also know that 14 CFR section 91.103 requires you to be familiar with “all” available information concerning a flight. Technically that means that you need to know all the V-speeds in terms of both definition and value — but some are more important than others. For simplicity, I have limited the list to speeds used for a single-engine airplane, and for convenience, I've grouped them in terms of performance speeds, and limitation speeds.

Performance:	
V_R	Rotation speed. As stated in 14 CFR part 23, V _R is “the speed at which the pilot makes a control input, with the intention of lifting the airplane out of contact with the runway or water surface.” To reduce the possibility of an inadvertent stall during takeoff, regulations state that V _R cannot be less than V _{S1} .
V_X	V _X represents the airspeed for best angle of climb, and it results in the greatest amount of altitude over the shortest distance. You’ll want to use this speed for a short-field takeoff, especially if you need to clear obstacles in the departure path. It’s important to practice this maneuver (and flying at this airspeed) on a regular basis, because lack of experience and/or proficiency in short-field / obstacle clearance operations could lead to an inadvertent takeoff/departure stall.
V_Y	V _Y is the airspeed for best rate of climb, which produces the greatest amount of altitude gain over the shortest period of time. V _Y is the “standard” airspeed to establish during the post-takeoff climb and departure phase of flight.

Limitations:	
V_A	<p>V_A is the aircraft’s design maneuvering speed. Flying at or below V_A, means that the airplane will stall before the structure is damaged by excessive loads. If you encounter a gust that causes a sudden, significant increase in load factor while flying above V_A, the aircraft could experience structural failure.</p> <p>Another important thing to understand is that V_A changes with the aircraft weight: V_A decreases as weight decreases, and it increases as aircraft weight increases.</p> <p>It is a mistake to assume that as long as you are at or below V_A, you can move the controls from stop to stop repeatedly without damaging the aircraft. To clarify this point, 14 CFR part 25 states that “flying at or below the design maneuvering speed does not allow a pilot to make multiple large control inputs in one airplane axis or single full control inputs in more than one airplane axis at a time without endangering the airplane’s structure.” Although GA aircraft are certificated under 14 CFR part 23, this point is still valid.</p>
V_{FE}	Represented by the top of the white arc on the airspeed indicator, V _{FE} is the maximum flap extended speed. If you allow your airspeed to increase above V _{FE} with flaps extended, you may damage or even lose one or both flaps. Note that some aircraft are designed to allow partial flap extension above V _{FE} , so consult the Pilot Operating Handbook/Aircraft Flight Manual to be sure you understand the limitations for your specific make and model.
V_{LE}	V _{LE} represents the maximum airspeed for operating with the landing gear extended. A related speed is V _{LO} , which is the maximum speed for “operating” (extending or retracting) the landing gear.
V_{NE}	This one is easy – “never exceed” means exactly what it says. It is an absolute limit, and you should never, ever operate as if there were a “buffer” beyond this speed. Such assumptions are likely to result in structural failure.
V_{NO}	Maximum structural cruising speed — the highest speed that you can safely fly in smooth air — is shown as the upper limit of the green arc on the airspeed indicator. If you fly above V _{NO} — in the yellow arc or “caution range” — and you encounter air that is not smooth, you could cause damage to the aircraft.
V_S	V _S is the stalling speed, or the minimum steady flight speed at which the airplane is controllable — in other words, the airplane will stall if you fly any slower than this speed. Although the “stalling speed” part of the definition leads pilots to believe they can avoid a stall by flying at or above a specific numerical value, it is very important to understand that a stall results from exceeding the critical angle of attack. It’s better to think of V _S not as a numerical value, but rather the point at which your airplane is at the critical angle of attack in straight-and-level flight. A stall can occur at any airspeed, in any attitude. V _S is the point at which the air flowing over the upper surface of the wing can no longer flow smoothly to the trailing edge.

Do V-speeds Change?

As illustrated by some of the V-speeds listed in the chart above, the short answer is yes. Conditions that can affect the numerical value of V-speeds include:

- Aircraft weight and configuration.
- Altitude
- Temperature (which has implications for pressure altitude)
- Runway conditions (e.g., contaminated runway)

V-speeds defined in 14 CFR part 1	
V_A	design maneuvering speed
V_B	design speed for maximum gust intensity
V_C	design cruising speed
V_D	design diving speed
V_{DF}/MDF	demonstrated flight diving speed
V_{EF}	speed at which the critical engine is assumed to fail during takeoff
V_F	design flap speed
V_{FC}/MFC	maximum speed for stability characteristics
V_{FE}	maximum flap extended speed
V_{FTO}	final takeoff speed
V_H	maximum speed in level flight with maximum continuous power
V_{LE}	maximum landing gear extended speed
V_{LO}	maximum landing gear operating speed
V_{LOF}	lift-off speed
V_{MC}	minimum control airspeed with the critical engine inoperative
V_{MO}/MMO	maximum operating limit speed
V_{MU}	minimum unstick speed
V_{NE}	never-exceed speed
V_{NO}	maximum structural cruising speed
V_R	rotation speed
V_{REF}	reference landing speed
V_S	stalling speed or minimum steady flight speed at which the airplane is controllable
V_{S0}	stalling speed or minimum steady flight speed in the landing configuration
V_{S1}	stalling speed or minimum steady flight speed obtained in a specific configuration
V_{SR}	reference stall speed
V_{SR0}	reference stall speed in the landing configuration
V_{SR1}	reference stall speed in a specific configuration
V_{SW}	speed at which onset of natural or artificial stall warning occurs
V_{TOSS}	takeoff safety speed for Category A aircraft
V_X	speed for best angle of climb
V_Y	speed for best rate of climb
V_1	maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. V_1 also means the minimum speed in the takeoff, following a failure of the critical engine at V_{EF} , at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance.
V_2	takeoff safety speed
V_{2min}	minimum takeoff safety speed



Photos by James Williams

As you know (and as shown in the chart), V_A is one example, because the numerical value of V_A changes with weight. Another example concerns V_X and V_Y : as altitude increases, V_X increases slightly and V_Y decreases. V_X and V_Y are equal when the airplane reaches its absolute ceiling.

The Need for (Proper) Speed

Knowing and using the proper speeds for various phases of flight in your specific aircraft is obviously good airmanship. More fundamentally, it is important for safety, because airspeed control is the key to getting the maximum performance from your aircraft without violating limitations that could result in structural damage or failure. 

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TOM HOFFMANN

Your Airplane Is Ready To Print!

How 3-D Printing Technology is Taking Shape in the Aerospace Industry

Fans of the television comedy series *Portlandia* will recall an episode where the fictional mayor of Portland, Oregon (played by Kyle MacLachlan) unveils the city's very own 3-D printer, a device that promises to help bolster Portland as a first-class city and dispel its stigma of being overly quaint. Faced with mounting budget woes, the mayor is soon made painfully aware of the printer's shortcomings, realizing he cannot merely "print" a new school or a new road. His farcical expectations of what a 3-D printer can do are amusing to say the least, but I think it also speaks to the greater issue of how many misunderstandings surround this revolutionary new technology.

To some it may seem like a passing fad, while others claim it's a panacea for all the world's problems. Neither description quite fits the bill, but it is safe to say that 3-D printing, with its breakthroughs in efficiency, durability, and cost-control, is changing the way we think about the manufacturing process as a whole. And, as this technology grows even more sophisticated, it offers increasingly innovative ways to produce everything from a simple plastic cup holder to rocket engine parts that can withstand the extreme rigors of space launch.

It seems only natural to consider how this type of technology could be beneficial to aerospace, an industry inextricably linked to expensive and time-limited parts, complex design procedures, and a

strict penchant for jettisoning every ounce of unnecessary weight. While 3-D printing does hold some exciting potential for the aviation industry in these very areas, there are still numerous challenges and concerns that need to be addressed before we start stocking up on "toner." Let's start by taking a closer look at this transformative technology to see how it could benefit the aviation industry, as well as review the FAA's safety strategy for addressing the challenges going forward.

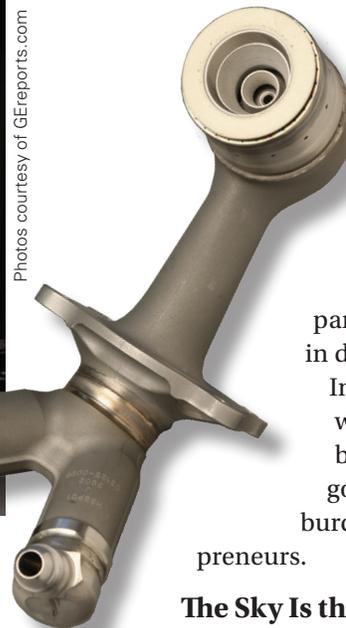
Everything's Better in 3-D

So, what is 3-D printing? For starters, the industry's preferred term — additive manufacturing (AM) — better reflects what has developed into a more multi-faceted process. As the name implies, AM involves a machine that adds material(s) layer by layer to form a 3-dimensional object. The object's design and dimensions are driven by a computer aided design (CAD) file that contains the blueprints of the virtual object.

In its earlier days (circa 1980s), "3-D printing" was focused mainly on polymers and plastics, but it has now expanded to include more mainstream use of metal, ceramic, glass and dozens of other materials, the practical applications for which are mind-boggling. AM techniques have also evolved greatly, from special inkjet printer heads, to high-tech laser beams that melt or sinter layers of materials together.



Photos courtesy of GEREports.com



General Electric Aviation will begin using 3-D printed fuel nozzles (right) in its new CFM LEAP engines in 2016.

The primary AM processes for metallic materials are grouped into two categories: directed energy deposition, which directs a beam of energy to melt wire or powder material that is added; and powder bed fusion, which involves sequential scanning of a beam onto a pre-deposited powder bed. The final step for many AM-produced parts is a finishing process that involves cooling and solidification, as well as surface smoothing, cleaning, and sterilizing, if needed. Some AM techniques can even integrate color and eliminate the need for painting altogether.

Waste Not, Want Not

The additive manufacturing process is quite a big step from traditional machining techniques, which, due to the advent of AM, are now identified as “subtractive” manufacturing. This is where objects are cut or milled from a larger piece of stock material, either with a machine or with hand tools like a blacksmith would use. Neither stand out as being particularly efficient; the collection of curlicue metal filings on the floor of a busy machine shop is a dead giveaway of the wasted material that results. Then there are the limited options you have when it comes to the scalability of what you’re producing. Need that widget just an inch wider? That likely would involve re-tooling or redesigning your machine. Good luck with that.

Therein lies the beauty of AM; a fundamentally new type of manufacturing whose impressive benefits have caught the eye of many government, industry, and business leaders, and especially those in the aerospace industry. The highlights of its resume include reduced costs (via less material, less build-time, and fewer parts) and enhanced performance (via improved strength and durability, decreased weight, and on-the-fly optimization). Prototyping is another area that has made a name

for AM. Instead of waiting months for product prototypes, companies can design mock-ups in days, sometimes hours. In addition, the ease with which modifications can be instantly realized before going to market is a huge burden lifted for eager entrepreneurs.

The Sky Is the Limit ... or Is It?

“AM is a total game-changer,” says Jim Kabbara, an aerospace engineer with the FAA’s Aircraft Certification Office. “There are many great benefits, but also some huge risks. We are still trying to understand all its properties. There are at least 50 variables with this technology, maybe more, that we need to understand better.”

As an example, Kabbara points out that with traditional manufacturing techniques, there is a long history that has led to understanding the effects that machining, heat treating, and forging can have on materials, including damage tolerance and fatigue. On the flip side, little is known about AM alloys or their mechanical properties. “Is it casting? Is it welding? There are no standards for using powder,” says Kabbara.

To help decipher those mysteries and lay the regulatory groundwork for introducing AM technology, Kabbara was tasked with leading a working group to focus on learning as much as possible. The FAA Additive Manufacturing National Team (AMNT), which first met in late 2014, includes specialists and engineers from several different areas of the FAA, including engine and airframe design, metallurgy, research and development, inspection, and GA product certification. The team is also currently engaged with other government agencies (NASA, Department of Defense) and academia (MIT, Wichita State University) to learn as much as possible about the intricacies of AM. The goal of this collaboration is to also assess the applicability of current regulations to AM products and to initiate the development of guidance to allow these products to be safely used in certified structure.

“As with any new technology, standardization is a huge issue,” says Rusty Jones, a senior technical specialist with the FAA’s Aircraft Maintenance Division and the non-destructive testing lead for the AMNT. “There is a need to develop process specifications

and quality processes to assure uniformity of parts.”

A lack of industry standards and guidance are also big concerns for the AMNT. With more companies already looking to use this technology, it’s important for the FAA to work proactively and set up a framework that will safely and consistently manage the introduction of AM parts.

The AMNT is taking a first step in information coordination with a memo it plans to issue later this year to all of the FAA Aircraft Certification Offices and Manufacturing Inspection Offices. According to Kabbara, “the memo will standardize some of the verbiage and terms used, provide basic guidance on how to respond to AM inquiries and requests in the field, and establish a method of tracking who comes to us for AM applications.” Based on the data it collects, the team will begin evaluating the foundational policy, guidance, and rulemaking needed to move forward and enable use of the technology with minimum interference.

Print Job in Queue

For some aerospace companies, the future of AM is now. Boeing currently has 30 AM-produced parts on its 787 *Dreamliner*. Also, General Electric Aviation will begin using 3-D printed fuel nozzles in its new CFM LEAP jet engines; a first for critical parts on an engine platform. According to GE, the AM process will create a nozzle that is 25 percent lighter, five times as durable, and reduce from 18 to one the number of parts required to create it. With several thousand of these engines on order, GE is aiming to create more than 100,000 AM-produced parts by the end of the decade.

In case you needed more proof of exciting things to come, a group of researchers at Australia’s Monash University recently created the world’s first 3-D printed jet engine. The engine was modeled from a small auxiliary power unit that was completely disassembled, scanned, and then reproduced using lasers and metal alloy powder.

Yet another AM milestone was achieved by a group of University of California students in 2013 when they successfully built and test fired a 3-D printed metal rocket engine. The student project was sponsored in part by NASA, which has been quite active with several of its own AM pursuits. Just last November, NASA completed hot-fire tests on an advanced rocket engine thrust chamber assembly using copper alloy materials. The agency stated that this was the first time a series of rigorous tests confirmed that additive manufactured copper parts could withstand the heat and pressure required of

combustion engines used in space launches.

Not to be outdone by these interstellar AM projects is the delivery of the International Space Station’s first 3-D printer last fall. In December, a design file was beamed up to the ISS in true “Star Trek” fashion, and voilà; a plastic ratchet wrench was born. Although it wasn’t used in space, the tool will instead be studied back on the ground to determine if there are any differences in the AM process due to micro-gravity. That’s good assurance for those folks aspiring to be the first on Mars a few years from now.

It’s not just about the commercial and space transportation industries when it comes to reaping the benefits of AM. Mark James, an engineer with the FAA’s Small Airplane Directorate, believes AM could be a great benefit to the GA community as well. “In GA especially, sometimes parts are hard to find for airplanes orphaned by companies that have gone out of business,” says James, who also represents GA concerns on the AMNT. “Parts on demand with no cost for warehousing could save time and money for manufacturers and consumers alike. Assuming of course that compliance to the type design can be shown. That’s one of the hurdles we have today for orphaned airplanes.”

Printer Pioneers

So what does the future hold with AM in the aviation world? Will we soon be able to load up an airplane part design on a personal computer and just hit the print key? That may still be a while off, but the future is promising. Advances in AM technology are allowing researchers to experiment with combining materials in new and innovative ways, which may help answer some of the long-term strength and durability issues that give some scientists pause.

“We’re just now scratching the surface with AM,” says Kabbara. “The potential is there with this technology, but we must use it wisely and understand what we’re using. I’m hoping the FAA can become an enabler for the AM industry to expand so that more people can realize its significant benefits.” 

It is safe to say additive manufacturing, with its breakthroughs in efficiency, durability, and cost-control, is changing the way we think about the manufacturing process as a whole.

Tom Hoffmann is the managing editor of FAA Safety Briefing. He is a commercial pilot and holds an A&P certificate.

Learn More

GE Video on Additive Manufacturing

www.ge.com/stories/advanced-manufacturing

Categorical Confusion

I'm a stickler for accuracy when it comes to words in general, and especially for terms used in aviation. You won't ever hear me talking about a pilot's "license," but I've mostly conceded that getting everyone to call it by its proper name — pilot *certificate* — is a losing battle. However, I am still fighting the good fight against the widespread tendency to use the terms "certificate" and "rating" as if they were synonyms. So here goes!

Certificate = Privilege Level

The document that the FAA issues is a certificate, which Merriam-Webster defines as "a document certifying that one has fulfilled the requirements of, and may practice in, a field."

A pilot is certificated to fly aircraft at one or more privilege levels: Student, Sport, Recreational, Private, Commercial, and Airline Transport Pilot (ATP).

Although we naturally think of flight instructors as pilots, the certificate issued to a flight instructor is considered to be an instructor certificate, and not a pilot certificate. However, a commercial or ATP-level pilot certificate is generally required for issuance and exercise of a flight instructor certificate.

Rating = Operating Privilege

A rating is "a statement that, as part of a certificate, sets forth special conditions, privileges, or limitations." Ratings specify what, and/or how, the pilot is qualified to fly.

Except for pilots at the student and sport certification levels (more below), pilots at each certificate level are *rated* to fly aircraft in at least one specific category and, if applicable, class. A typical rating on a private pilot certificate is "airplane single engine land." If you complete additional training and testing requirements for a multi-engine class rating, your private pilot certificate will then have ratings for "airplane single and multi-engine land."

For a pilot to legally act as pilot-in-command of any aircraft that is more than 12,500 pounds maximum gross takeoff weight or of any turbojet, an aircraft-specific type rating (e.g., B737) is required, in addition to the appropriate aircraft category and class rating.

Ratings are also added to a certificate when the pilot qualifies for a certain operating privilege, such as an instrument rating, in a specific aircraft category and class.

Endorsement = Completion of Specified Training

An endorsement attests to completion of ground and/or flight training required for specific operating privileges, or for airman certification testing. Except for certain endorsements made in pen and ink on a student pilot certificate, endorsements are generally made in the pilot's logbook. The endorsements required by Title 14 Code of Federal Regulations (14 CFR) part 61 fall into several broad categories:

Student Pilots: Because a student pilot certificate has no aircraft category and class ratings, operating privileges and limitations for solo flight are conveyed exclusively through instructor endorsements that specify not just aircraft category and class, but also specific make and model. Student pilot endorsements can also specify weather limitations.

Sport Pilots: Like a student pilot certificate, a sport pilot certificate is issued without aircraft category and class ratings. Logbook endorsements specify the category, class, make, and model of aircraft that the sport pilot is authorized to fly as pilot in command.

Testing for Certificate or Rating: To take a knowledge test or practical test for most pilot certificates and ratings, the applicant must have endorsements attesting to aeronautical knowledge, flight proficiency, aeronautical experience, and practical test preparation.

Recurrent Training: To maintain the operating privileges conferred by a pilot certificate or instrument rating, the pilot must have an endorsement for satisfactory completion of required recurrent training (e.g., flight review or instrument proficiency check).

Aircraft Characteristics: The requirement for a type rating is limited to large (greater than 12,500 pounds maximum gross takeoff weight) and turbojet-powered aircraft. However, certain small and piston-powered aircraft have characteristics that require additional training for safe operation. Endorsements related to aircraft characteristics include those for complex, high performance, high altitude, tailwheel, and glider ground operations.

Overrated?

Does it matter? I won't argue that it's a safety matter. Still, using correct terms is part of the "right stuff" for being a professionally-minded pilot. So humor me, please, and say it right!

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Photo Courtesy of Cessna



A TOUCH OF CLASS

SUSAN PARSON

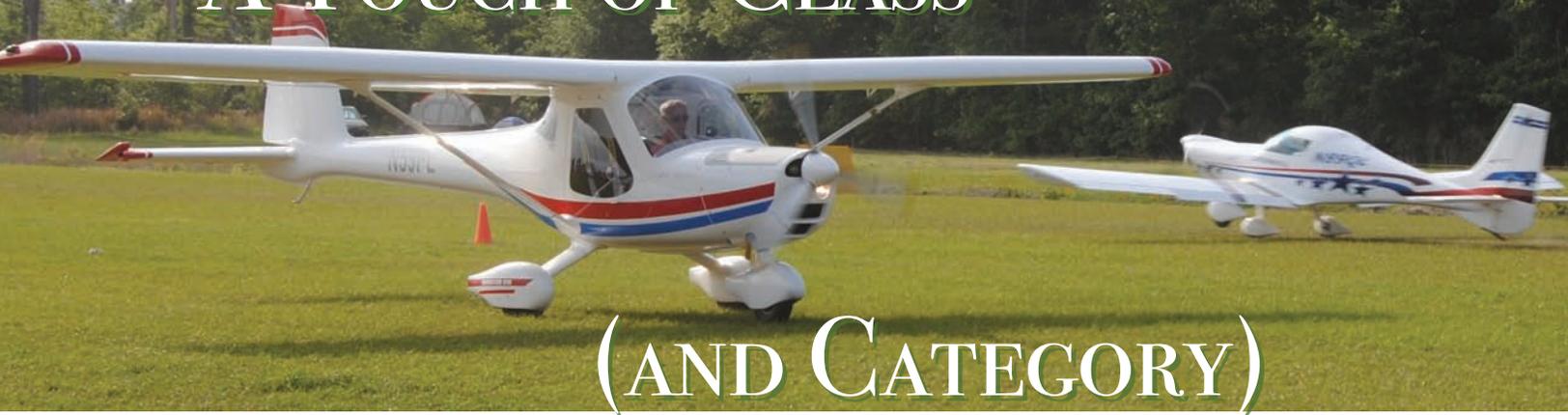


Photo by Tom Hoffmann

(AND CATEGORY)

Performance & Privileges

At some early stage of your aviation training, your instructor introduced the concepts of “category” and “class.” You learned (sort of) that category and class mean one thing for certification of aircraft, but they mean something different for certification of pilots. If your experience was anything like mine, you didn’t get much (if any) information about what those words meant, much less why they are applied differently to planes and pilots. So you dutifully found a way to memorize the words associated with category and class for each. You remembered it just long enough to get through the knowledge test, and after that you never thought about it again. Sound familiar?

Once I passed my private pilot knowledge test, I personally put notions of category and class completely out of mind until I started working toward my ground and flight instructor qualifications. At that

stage, it wasn’t enough to parrot the textbook definitions. I had to actually *understand* these heretofore confusing concepts in order to explain them, first to the FAA inspector who administered the practical test and then to my students. As the saying goes, words matter — and these particular words are helpful in terms of understanding certification requirements for performance (planes) and privileges (people).

Aircraft Category = What Can It Do?

As used with the certification of aircraft, the term “category” refers to aircraft grouping according to intended use and operating limitations. The aircraft categories can further be grouped according to whether they qualify for a standard airworthiness certificate or a special airworthiness certificate.

The following chart provides a broad summary of the main aircraft categories:

Category	Airworthiness Certificate Type	14 CFR part	General Characteristics
<i>14 CFR part 25: Airworthiness Standards: Transport Category Airplanes</i>			
Transport	Standard	25	<ul style="list-style-type: none">• Jets with 10 or more seats or a maximum takeoff weight (MTOW) greater than 12,500 lbs• Propeller-driven airplanes with greater than 19 seats or a MTOW greater than 19,000 lbs• At least two engines• Flown by at least two pilots• “Fail-safe” - any element can fail, but the risk of such a failure causing an accident must be extremely low.• Load limit from -1 to +2.5 Gs (or up to +3.8 Gs, depending on design takeoff weight)

Category	Airworthiness Certificate Type	14 CFR part	General Characteristics
<i>14 CFR part 23: Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes</i>			
Commuter	Standard	23	<ul style="list-style-type: none"> • Propeller-driven, multiengine airplanes • Seating, excl. pilot seats, of 19 or less • MTOW of 19,000 pounds or less. • Approved for any maneuver incident to normal flying, stalls (except whip stalls), and steep turns, in which bank angle is not more than 60° • Load limit from -1.52 to +3.8 Gs
Normal	Standard	23	<ul style="list-style-type: none"> • Seating, excl. pilot seats, of nine or less • MTOW of 12,500 pounds or less • Approved for non-acrobatic operation (i.e., any maneuver incident to normal flying; stalls (except whip stalls); and lazy eights, chandelles, and steep turns) in which bank angle is not more than 60° • Load limit from -1.52 to +3.8 Gs
Utility	Standard	23	<ul style="list-style-type: none"> • Seating, excl. pilot seats, of nine or less • MTOW of 12,500 pounds or less • Approved for limited acrobatic operation: stalls (except whip stalls); lazy eights, chandelles, steep turns; spins (if approved for the particular type of airplane). Bank angle more than 60° but not more than 90° • Load limit from -1.76 to +4.4 Gs
Acrobatic	Standard	23	<ul style="list-style-type: none"> • Seating, excl. pilot seats, of nine or less • MTOW of 12,500 pounds or less • Intended for use without restrictions, other than those shown to be necessary as a result of required flight tests. • Load limit from -3 to +6 Gs

<i>14 CFR part 21: Certification Procedures for Products and Parts</i>			
Primary	Special	21.184	<ul style="list-style-type: none"> • Manufactured under a production certificate, including aircraft assembled by another person from a kit provided by the holder of the production certificate and under the supervision and quality control of that holder • FAA may inspect the aircraft to determine conformity to the type design and condition for safe operation
Restricted	Special	21.25 21.185	<ul style="list-style-type: none"> • Agricultural • Forest and wildlife conservation • Aerial surveying • Patrolling (pipelines, power lines) • Weather control • Aerial advertising

Category	Airworthiness Certificate Type	14 CFR part	General Characteristics
<i>14 CFR part 21: Certification Procedures for Products and Parts (cont.)</i>			
Limited	Special	21.189	<ul style="list-style-type: none"> • Surplus military aircraft converted to civilian use under these conditions: <ul style="list-style-type: none"> • The aircraft has, and conforms to, a limited type certificate. • The FAA has determined that the aircraft is safe to operate. • Operations may not include carrying passengers or cargo for hire. • FAA may prescribe additional limitations necessary for safe operation.
Light Sport	Special	21.190	<ul style="list-style-type: none"> • A light-sport aircraft, other than a gyroplane, kit-built, or transitioning ultralight-like vehicle
Experimental	Special	21.191 21.193 21.195	<ul style="list-style-type: none"> • Research and development • Show compliance with regulations • Crew training • Exhibition • Air racing • Market surveys • Operating amateur-built aircraft • Operating kit-built aircraft • Operating light-sport aircraft • Unmanned Aircraft Systems (UAS)
Provisional	Special	21 Subpart C	<ul style="list-style-type: none"> • Aircraft with a “provisional” category type certificate for special operations and operating limitations

This chart is by no means exhaustive, either in scope or in detail. For that, you need to refer to the appropriate section(s) of 14 CFR. It is also important

As used in the certification of aircraft, the term “category” refers to aircraft grouping according to intended use and operating limitations.

to understand that the references shown in the chart address airworthiness and certification standards, which are only part of the story. For operating rules and limitations applicable to a particular aircraft category and/or class, you’ll need to check the appropriate sections of 14 CFR part 91.

The bottom line is that understanding at least the basic certification requirements for each aircraft category gives you important information on what the aircraft can and cannot do for you.

Aircraft Class = How Does It Fly?

For aircraft certification purposes, “class” simply refers to a broad grouping of aircraft having similar characteristics in terms of propulsion, flight, or landing. The major class distinctions for aircraft

certification are: airplane; rotorcraft; glider; balloon; landplane; and seaplane.

To put aircraft category and class into more familiar terms, here are a few examples based on the aircraft GA pilots are most likely to fly:

- Normal (category) airplane (class)
- Utility (category) airplane (class)
- Acrobatic (category) airplane (class)

Pilot Certificates & Ratings

Before we turn to category and class for airmen, take a look at this issue’s “Checklist” for a clarification of the very frequently garbled terminology on pilot certificates and ratings. A surprising number of pilots — and an even more surprising number of instructors — tend to use the terms interchangeably, or to say “rating” when it should be “certificate.” In a nutshell:

A pilot is *certificated* to fly aircraft at one or more named privilege levels, which include student, sport, recreational, private, commercial, and airline

transport pilot (ATP). When you talk about your pilot *certificate*, you are referring to the privilege level (e.g., private pilot). The type of certificate you hold determines your basic privilege level, and each level inherently includes certain privileges and limitations (e.g., to fly — or not — for compensation).

Except for pilots at the student and sport certification levels (see “Checklist” for details), pilots at each certificate level are *rated* to fly aircraft in at least one specific category and (if applicable) class. Now let’s look at what that means.

Airman Category = What Sort of Aircraft Can You Fly?

For purposes of ratings on a pilot certificate, there are seven aircraft categories:

- Airplane
- Rotorcraft
- Glider
- Lighter than air
- Powered lift
- Powered parachute
- Weight-shift-control

Once you are beyond the student pilot certification level, your pilot certificate will list at least one rating that includes at least one of the seven aircraft categories stated above.

Airman Class = What “Flavor” Can You Fly?

In addition to stating a category level, the pilot certificate must include at least one class rating if the aircraft category is divided into classes. (Note: A type rating is “above and beyond” a class rating; see “Checklist” for details.)

Here are the major class divisions:

- Airplane category is divided into single-engine land (ASEL), multi-engine land (AMEL), single-engine sea (ASES), and multi-engine sea (AMES) classes
- Rotorcraft category is divided into helicopter and gyroplane classes
- Lighter-than-air category is divided into airship and balloon classes
- Powered parachute category is divided into powered parachute land and powered parachute sea
- Weight-shift-control category is divided into weight-shift-control land and weight-shift-control sea

Note that the powered lift and glider categories are not divided into classes, so a rating in either of these aircraft categories will stand by itself. In other cases, though, your pilot certificate will include both. For example, the most common initial aircraft category and class rating on a newly-issued private pilot certificate is airplane single engine land.

Head of the Class

There’s a lot to learn in aviation, and it’s understandable if you, like me, initially let the concepts of category and class bounce off an already overtaxed brain. Because of what these terms convey about aircraft performance and airman privilege, though, I hope you’ll step to the head of the class by taking a second look. ✈️

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GA SAFETY ON THE GO



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The **Bigger BANG** Theory



Photo by H. Dean Chamberlain

The Quest for More Power

This highly modified P-51 Mustang Reno Air Racer uses supercharging well beyond normal operating ranges to produce massive horsepower.

This airplane has too much power,” said no one ever. Okay, maybe it’s possible someone at some point in recorded history has uttered that phrase — but it seems unlikely.

One of the best ways to go faster in your airplane or your car is by adding more horsepower. There are several ways to accomplish this goal. Since horsepower is essentially a measure of work done over time, increasing either the size of the “bang,” or the number of bangs per unit of time, will increase horsepower. The easiest way to upsize your “bang” in both automotive and aviation applications is to add displacement, i.e., engine cylinder volume. A larger engine generates more power but the current initiative to improve fuel economy and reduce emissions is pushing engine manufacturers away from the tried and true “there’s no replacement for displacement,” motto.

Another option for more power is for the engine to run faster. A higher revolution per minute (rpm) generates more power by increasing the number of bangs per a given unit of time. This approach has worked quite well in cars, but doesn’t work as effectively in airplanes due to the requirement for a reduction gearbox to lower the rpm to a more manageable range for propellers. Cars naturally have these gearboxes (transmissions), but smaller GA airplanes generally don’t, with a few exceptions like the Cessna C-175 *Skylark*. Since neither of these options is that great, how is a tried and true power junkie able to increase power?

Take a Deep Breath

Allow me to introduce the magic of forced induction. To increase the size of the bang without increasing the size of the engine or the speed at which it turns, we need to find a way to get more fuel into the cylinder. By itself, this extra fuel will cause the engine to run too rich, so we need to balance it with more air. By cramming both extra air and fuel into the cylinder, we can get a bigger bang or maintain a certain bang size at a higher altitude than would be possible without forced induction. This action is carried out by a pump on the front of the engine that compresses the intake air. The pumping can be accomplished in one of two ways.

Superpower Supercharger

The first method is with a good old-fashioned supercharger. This is a compressor — sometimes called a blower — that is driven by the engine just like an alternator, air conditioning unit, or any other accessory. The advantage to this method is that it requires less plumbing and doesn’t experience any lag or spool time (more on that later). The main disadvantage is that the energy used to power the compressor is drawn from the engine. This drag on the engine means that a supercharger is more about net gains than absolute. In fact, some superchargers can require well in excess of 100 horsepower to run. Even though your supercharger may be capable of adding 400 horsepower to a given engine, you effectively

lose a percentage of that output to power the compressor. So if your 400 horsepower supercharger took 50 horsepower to run, you'd net 350 horsepower to your overall total. While it's still very much a net positive, it's not as efficient as it might be. For these reasons, among others, supercharging has fallen out of favor since the Second World War. This leads us to our next form of forced induction.

Terrific Turbocharging

Turbocharging is similar to a supercharger in that it helps deliver more air to the induction system. It differs in how it powers the compressor. A turbocharger uses the exhaust gas from the engine to turn the compressor in a way that is very similar to the cold and hot sections of a jet engine. In this system, however, the compressed air is being delivered to an internal combustion engine rather than straight into a combustion chamber. The key advantage of turbocharging is that it captures "free" or otherwise wasted energy from the exhaust gases.

The engineers out there are probably screaming "there's no such thing as free!" — and they are right. The downside is that turbocharged engines tend to run hotter and harder than their normally aspirated counterparts. Another disadvantage of turbocharging is that to compress the air, you must first have sufficient exhaust gas flowing through the turbine to run the compressor. This creates a phenomenon known as "turbo lag." Turbo lag occurs when the power delivery is delayed while the turbos spool up in response to the increased exhaust gas flow created by advancing the throttle. This creates issues in aviation, but it is more noticeable in automotive applications.

Turbocharged engines also require more discipline from the pilot. Depending on the setup, rapid throttle movements could potentially damage or destroy an engine. Turbochargers also require a cool down period after flight. Because the turbines spin at very high rates — at times in excess of 80,000 rpm — they require significant cooling and lubrication. This requirement is accomplished by circulating engine oil through the bearings. If you were to shut down the engine before the turbos have properly cooled, the flow of engine oil would also stop and the oil left in the turbos would literally cook, causing hard carbon deposits to build up on the bearings. This, in turn, restricts future oil flow and leads to more issues.

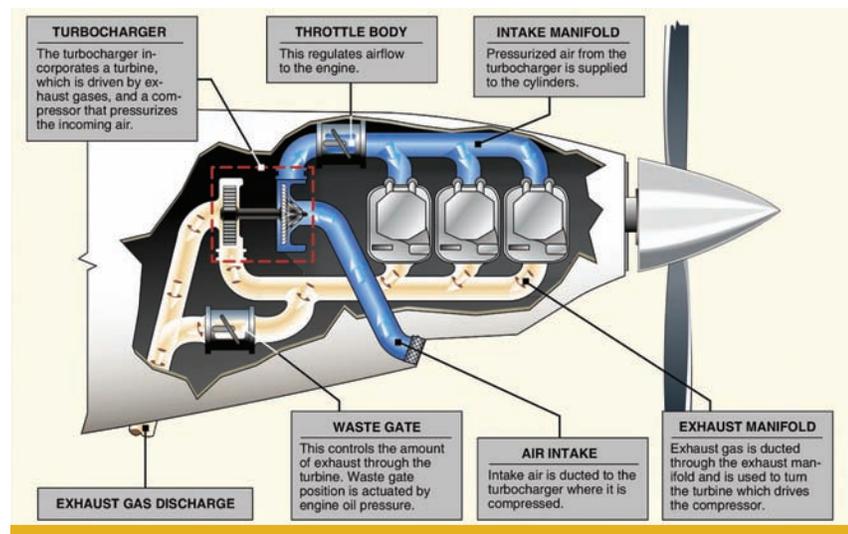
Give Me a Boost

Before we get too deep into the technical discussion, let's look at how this technology can be

applied, because it can make a big difference. On a standard day at sea level, a normally aspirated aircraft would produce about 30 inches of mercury (inHg) in manifold pressure, which is another way to measure engine power produced by a piston engine with a constant speed propeller. (We'll round the pressure up from 29.92 to make the math easier.) In reality, the number would be lower due to losses in the intake system. So that normally aspirated airplane's engine would decrease in performance as atmospheric pressure dropped, by 1 inHg per 1,000 feet, to the point where at 5,000 feet, the theoretical maximum would be 25 inHg.

In the first form of turbocharging, we would look to boost the incoming manifold pressure significantly. This could be to 35 or 40 inHg while at sea level, which allows us to generate more power with a smaller engine. Turbocharging in this way can create fantastic power. Great examples include the turbocharged Formula One engines of the mid 1980s, which at their maximum power settings ran something more than 160 inHg and turned out around 1,300 horsepower from a tiny 1.5 liter engine. For an aviation equivalent we turn to the Reno Air Racers, which pull anywhere between 70 and 130 inHg. However, these planes use superchargers rather than turbochargers on engines ranging between 27 liters and nearly 55 liters of displacement.

These applications are an example of "boosted turbocharging." This approach does allow the generation of massive horsepower numbers, but forced induction can be hard on the engine. In fact, the highly boosted Formula One cars could only sustain



Turbocharger components



Photos by George Soteropoulos



Photos by Anne X Graham

The P-38 Lightning (left) and P-47 Thunderbolt (right), along with the B-17 Flying Fortress, are a few of the rare turbocharged WWII airplanes.

maximum boost for two to three laps before giving up the ghost, and it is a similar story for our air races. That is why most boosted engines run much, much lower levels of boost. Throttle movements need to be made deliberately to avoid over-boosting these engines.

The New Normal

The other way to turbocharge an airplane engine is called turbo-normalizing. This is where a turbocharger is used to maintain sea level pressure up to a critical altitude. After that point, the manifold pressure drops off at the same one inch per 1,000 feet. This allows the aircraft to fly higher and faster by making more power at altitude (than with normal aspiration) and having less drag due to lower air density. Essentially, the engine is performing as if it's at sea level while your airframe gets to take advan-

tage of the thin air. This approach is generally easier on the engine, because it imposes less stress and lets it run at a lower temperature than the boosted approach. Many manufacturers (retrofit and OEM) even state that there is no reduction in time between overhauls for their turbo-normalized engines when compared to their normally aspirated counterparts.

Keeping Your Cool

One of the key control mechanisms for a turbocharging system (turbo boosting or turbo-normalizing) is a waste gate. The waste gate is a valve in the exhaust system that limits the amount of boost generated by controlling the amount of exhaust gas that flows to the turbine. In essence, the waste gate is a bypass valve that allows exhaust gases to skip the turbine when open. When closed, it allows all the gases to pass through the turbine. The waste gate can

Additional Training Required?

If you are considering flying or owning a turbocharged airplane, here are a few training options you may need in addition to aircraft specific training:

High Performance

Under 14 CFR section 61.31, any aircraft with an engine with more than 200 horsepower is considered high performance and requires training and an endorsement from an authorized instructor to act as pilot in command. A turbocharger alone would not render the aircraft high performance by definition, but most turbocharged aircraft fit into this category.

Complex Airplane

Also under 14 CFR section 61.31, training and an endorsement are required to operate a complex airplane. This is defined in 14 CFR section 61.1 as an airplane that has a retractable landing gear,

flaps, and a controllable pitch propeller, including airplanes equipped with an engine control system consisting of a digital computer and associated accessories for controlling the engine and propeller, such as a full authority digital engine control; or, in the case of a seaplane, flaps and a controllable pitch propeller, including seaplanes equipped with an engine control system consisting of a digital computer and associated accessories for controlling the engine and propeller, such as a full authority digital engine control. Again, a turbocharger is not considered part of a complex airplane by definition, but many turbocharged airplanes meet the criteria in other ways.

Pilot Ratings

Since the turbocharged (or turbo "normalized") engine often allows an airplane to fly higher, the pilot must be instrument rated to operate the aircraft when flying above 18,000 feet.

be opened, closed, or anywhere in between to generate the commanded boost pressure. Most systems nowadays use an automated control mechanism to manage the waste gate, but some older retrofit systems have a manual controller the pilot must actuate. This arrangement makes setting power a more detailed process than just pushing the throttle forward. Even with the automated systems, a more deliberate pace in throttle adjustment is recommended because these systems rely on engine oil to manage them. They can lag slightly in some conditions, which could cause momentary over-boost situations. Knowing what kind of waste gate system the aircraft has is important to how to correctly operate the aircraft.

A natural side effect of compressing a gas is increased heat and pressure. There is no way around basic physics. Too much intense heat and pressure in an engine is bad for any number of reasons, but one is the possibility of detonation, the spontaneous combustion of fuel in the cylinder. This is why most turbocharged engines have a lower compression ratio than their normally aspirated counterparts. Another way of dealing with this side effect is an intercooler, which is like a radiator for the compressed intake air. The air gets cooled as much as possible, and it reduces the risk of detonation while potentially improving performance. Intercoolers are a nice bonus, but they aren't

a strict requirement of a turbocharger system.

The Air Up There

With the rise of turbocharging, especially in the turbo-normalized form, GA pilots are able to access airspace like never before. That access adds flexibility in planning by opening up more cruising altitudes to avoid icing or adverse winds. But remember the engineers' warning that nothing is free. With access to higher altitudes come other restrictions, such as the requirement for supplemental oxygen (14 CFR section 91.211). To take the greatest advantage of a turbocharged airplane, you will likely need a supplemental oxygen system.

With Great Power Comes Great Responsibility

Turbocharging can be a great tool to expand the usefulness of your aircraft. While the tales of rampant engine explosions are largely unfounded, knowing how your system works and what that means is absolutely critical. As with any more advanced system, turbochargers require an advance in your aeronautical skills. 

James Williams is FAA Safety Briefing's associate editor and photo editor. He is also a pilot and ground instructor.

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Check Engine!

Everything that moves will eventually wear out and it goes without saying that your engine(s) is one of the most expensive moving components on your aircraft. One of the best ways to keep your down time and operating expenses low while increasing your safety margins is to detect and monitor engine wear and repair it before it fails.

Title 14 Code of Federal Regulations (14 CFR) part 91 requires that all civil aircraft be inspected at specific intervals to determine their overall condition. While most aircraft owners and operators are aware of 100-hour and annual inspections, there are other time and condition requirements that should be considered in order to insure minimum downtimes and maximize safety margins.

Time between overhauls, or TBO, is the manufacturer's recommended number of running hours or calendar time before an aircraft engine or other component requires overhaul. This time will vary from make and model and is usually dependent on how complex the engine is and how it is used. TBO is important because it establishes a set schedule for required inspection and subsequent maintenance, but one of the many questions that beleaguer aircraft owners is when should they eventually replace items that "pass" inspection.

Meet You Halfway

Interim inspections and engine monitoring can give owners (and maintenance technicians) the relieve they need by providing all of the necessary information to diagnose and resolve an engine repair before a "little wear and tear" turns into "a major problem." These interim checks are often excellent opportunities for the mechanic to discover, diagnose, and resolve potentially unsafe conditions before they become a time consuming and costly problem.

Interim inspections are just that — additional inspections that go above and beyond the interval that is required by regulation. Progressive inspections (section 91.409) are at the discretion of the owner, done with approval from the presiding flight standards district office, and can minimize maintenance downtime. This type of inspection works well for aircraft that are utilized in commercial operations and/or experience a high number of operational hours on an annual basis.

One way to know when additional inspections are necessary is by using an engine monitoring

device that records information about the health of your engine's fuel, ignition, induction, and turbo-charging systems when it matters the most; while your engine is running. The analysis can give you better insight into what is happening during the combustion process and can act as an early warning detection system.

Beeps, Squeaks, FADECs, and D/EECs

Engine diagnostic equipment can come in many different forms. One version is the external, hand-held test kit that attaches to ignition plugs and determines system functionality. It is a bit like a multimeter on steroids; a good test kit can check engine compression, magnetos, ignition leads, and engine timing, to name a few.

Engine data management (EDM) systems come in a variety of forms and are offered by a host of different companies. These handy little devices watch over your engine while you concentrate on flying the aircraft and, combined with a controller, can meter your mixture and exhaust gas temperature (EGT) to optimize lean-of-peak operations. Some brands even offer the interpretive software and/or provide professional analysis as to what your data might indicate. In most cases, you can upload your information directly to a website, and if need be, request a report when anomalies present themselves.

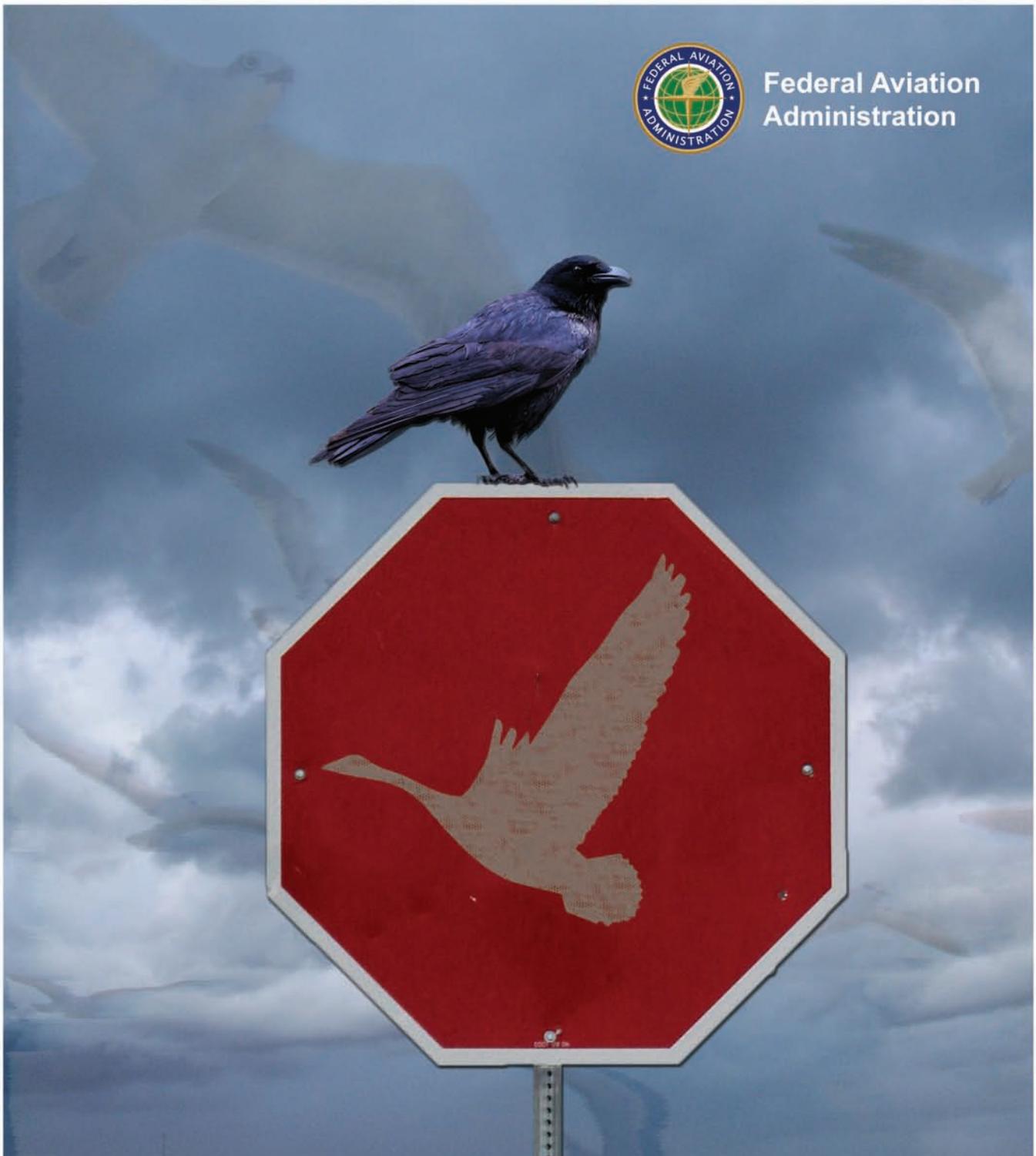
The brain that makes it all happen is the DEEC or EEC (digital/electronic engine control). It regulates the functions of the injection system to ensure the engine provides the power that is required of it. An engine control unit reads a multitude of sensors and then manipulates the engine by adjusting a series of actuators. Sensors include ones for airflow, engine cooling, throttle position, and fuel flow.

The younger, fancier cousin of the EEC is the full authority digital engine control (FADEC). Essentially this system does everything the EEC does — it even has an engine control unit in it — but there is no mechanical connection between the pilot and the fuel control (mixture is handled by the FADEC) and therefore engine management is much more precise.

All of this — the extra inspections and monitoring equipment — equals less distraction and better aircraft performance for the operators, but the real benefit is in being able to accurately predict, and then circumvent equipment failures. That means safer flying and less downtime (i.e., money) for all.



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NTSB:

MOST WANTED

Each year the National Transportation Safety Board (NTSB) produces a “Most Wanted” list which highlights key safety areas that previous years’ data has identified to be the most critical. While every mode of transportation is analyzed and represented, the aviation industry has the lion’s share of the recommendations.

Pertaining to all modes is: disconnect from deadly distractions, end substance impairment, require medical fitness for duty, and strengthen procedural compliance. Those specific to the aviation industry are enhance public helicopter safety, and prevent loss of control in flight in general aviation (GA).

Disconnect!

Quite simply, drivers and pilots do not always have their minds on the road. Smart phones, tablets, apps, etc, can detract from focusing on vital communications, instruments, or procedures. While new connectivity has enabled access to better, more timely information, it also enables distractions. The first step toward removing deadly distractions is to disconnect from non-critical information. Restrict activities and conversations during crucial aspects of flight.

Fit to Fly

Both substance abuse and overall medical fitness have played a factor in transportation accidents. While “under the influence” mishaps are staggering in motor vehicles, the aviation industry is no stranger to the phenomena. The prevalence of potentially impairing drugs has increased, as have positive marijuana results. But the most startling and commonly found impairing substance in fatal crashes was diphenhydramine, a sedating antihistamine found in over-the-counter medications.

This brings me to the latter of these two categories; some pilots are simply not medically fit to fly and yet they do anyway. The aviation medical certification system may be robust, but pilots are increasingly testing positive for sedating medications, obstructive sleep apnea, symptomatic coronary heart disease, and many other cognitive and physical medical conditions that deteriorate one’s ability to fly.

Follow Procedures

Good pilots can have bad days and a “bad day at the office” can turn into a real disaster. To help mitigate the inherent risk of being human (i.e., fallible)

we establish procedures and checklists — in particular for emergencies.

Together, we must find ways to strengthen procedural compliance, develop effective procedures and training, and ensure that pilots do what they are trained to do.

This includes rooting out inadequate company procedures, ensuring comprehensive training, and reemphasizing and reinforcing operator compliance.

Rotorcraft Safety

Helicopter safety is an often overlooked operation. Lack of appreciation for deteriorating weather conditions and failing to use an established “go, no-go” system proved to be a factor in several helicopter incidents in the last few years. Since 2004, the NTSB has investigated more than 130 accidents resulting in 50 fatalities. While this data is particular to helicopter operations listed as public assets (medevac, police, etc.) the same unnecessary risks these mishap pilots incurred are prevalent everywhere in the rotorcraft community. Increased emphasis on sound decision-making skills, flight risk evaluation, formalized dispatch and flight-following procedures, and fatigue management, can go a long way in positively affecting helicopter safety rates.

Loss of Control

GA operations still incur alarming “loss of aircraft control by pilot” rates every year. Statistically, approach to landing, maneuvering, and climb are the most dangerous phases of flight prone to LOC.

Losing control thousands of feet above the ground presents unique and, at times, fatal challenges; between 2001 and 2011, over 40 percent of fixed wing GA fatal accidents occurred because of this. Lack of proficiency and long intervals between training sessions and flights decrease pilot flying skills. While there are many courses, aircraft adaptations, and forums that provide ongoing education and flight currency, it is ultimately the responsibility of the pilot to participate in them.

“The Most Wanted List is our roadmap for 2015,” said NTSB Acting Chairman Christopher A. Hart. “At the NTSB we want to make new strides in transportation safety in 2015, and we want to lay the groundwork for years that are even safer.”

Check out www.nts.gov/mostwanted to read even more about each item on the list.

Summer of Safety

The U.S. Air Force declares Memorial Day weekend through Labor Day weekend the “Critical Days of Summer” to reinforce the need for aviators to exercise extra caution when flying and participating in aviation related events during these warmer months. Warmer temperatures not only can reduce aircraft performance substantially but they can also have a negative effect on human performance as well. With little warming, extreme temperatures can increase fatigue levels, elevate hydration needs, and place added stress to those working inside and outside the cockpit.

The FAA Rotorcraft Directorate likewise is calling for increased vigilance for the civil helicopter community from May 1 through September 30 in the United States.

In looking at accident statistics covering the past decade, helicopters have traditionally spiked during the warmer months — with July being the worst in averaging 20 accidents. To put this in perspective, the average for December was seven accidents making it the month yielding the least number of accidents.

Why more accidents occur in the warmer months is unclear. The Rotorcraft Directorate shows more flight hours are traditionally flown nationally in the months of June and July, whereas May and August fall in the same range of average flight hours flown as during cooler months. Data shows that most aerial application accidents occur in the warmer months, which coincides with the country’s growing season when weather is often less predictable.

Another suspected reason is that higher summer temperatures lead to higher density altitudes, which reduce the lift generated by rotor blades. The relation between the airspeed indicated on the instrument panel and the true airspeed also are subject to air density changes. Furthermore, the higher density altitudes decrease the power delivered by the aircraft’s engine, and when combined with the reduced aerodynamic effects, helicopters perform more sluggishly. Pilots can get themselves in trouble if they fail to plan a flight carefully. They may fly too fast, carry too much weight or conduct maneuvers that their helicopters were not designed for, especially in warmer weather.

The directorate’s safety campaign, however, may be taking hold in the helicopter community. The 128 accidents in the fiscal year that ended September 30

marked the lowest annual total in at least 32 years. Personal/private, instructional/training, and aerial applications had the largest percentage of those accidents at 21 percent, 17 percent, and 16 percent, respectively. Of the 128 accidents, 20 resulted in fatalities with 32 people losing their lives.

Here are several safety tips. Readers of this column have seen these recommendations before but we repeat them with hopes that the downward helicopter accident trend will continue.

- Avoid flying into fog or stormy weather. This may seem like common sense, but every year the directorate investigates accidents — often fatal — caused by pilots who took risks in bad weather. Pressing on is never a good idea.
- Fly no lower than 1,000 feet above ground level (AGL) whenever possible after takeoffs and landings to avoid wires, trees, and other obstacles. For some pilots (such as aerial applicators), that rule may be impractical. In these cases, helicopters should have wire strike protection systems to prevent emergency situations from occurring.
- Conduct a risk analysis before each flight. Ask yourself: Does the proposed task present safety risks? What is the probability of a mishap? Are the risks worth taking? Sometimes the wisest choice is to just turn around or land, even in a field or open parking lot. Questions and investigations by federal authorities will inevitably follow. Being asked questions by the FAA and the NTSB is better than having family members answer questions on your behalf.
- Use checklists to ensure helicopters are properly maintained and operated. The International Helicopter Safety Team recommends these pre-departure check lists available through this link: <http://easa.europa.eu/essi/ehest/2012/06/pre-departure-check-list/>
- Use the IM SAFE checklist to ensure you are fit to fly. Ask yourself about: Illness - Medication - Stress - Alcohol - Fatigue - Eating (and proper hydration).

(Continued on page 35)

Fast-track Your Medical Certificate

With FAA MedXPress, you can get your medical certificate faster than ever before.

Here's how: Before your appointment with your Aviation Medical Examiner (AME) simply go online to FAA MedXPress at <https://medxpress.faa.gov/> and electronically complete FAA Form 8500-8. Information entered into MedXPress will be available to your AME to review prior to and at the time of your medical examination, if you provide a confirmation number.

With this online option you can complete FAA Form 8500-8 in the privacy and comfort of your home and submit it before your appointment.

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ATTENTION:
As of Oct. 1, 2012, pilots
must use MedXpress
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Flight Forum

Our January/February edition of FAA Safety Briefing, Airspace and ATC, was a hit amongst our readers and in particular for those who follow us on Twitter (@FAASafetyBrief) and Facebook- (www.facebook.com/FAA). The following is a few of the comments that were posted to social media about this and other editions. Thanks for all of your comments and keep 'em coming!

Ken on Facebook about talking to ATC: I've asked for help a time or two they have ALWAYS been there when I needed them. One NORCAL controller pulled me out of a jam in IMC practicing approaches into KOAK. Spatial disorientation occurred I was fighting to keep it upright and together this one guy saw I was in trouble. His kind words spoken calmly was the saving grace he got me turned onto the localizer and into the clear. I never got a chance to thank him. If he's reading this God bless you I'm safe and alive today thanks to you.

Chris on Facebook about talking to ATC: The controller has a job because we fly. They are there to help us as we do everything possible to help them. This close relationship is called "team work" and serves all involved. Good communication promotes Aviation Safety.

Pat on Facebook about talking to ATC: For some reason I am always hesitant to ask for help. I know it's not rational. Must be an ego thing, or training, not sure.... Just so hard to break the fear that I'll be held accountable for some error I should of foreseen. Thanks for being there, ATC.

(Vertically Speaking continued)

- Watch out for complacency. Dust off your emergency procedures manual and read it carefully — your full attention is needed. Follow the rotorcraft flight manual's normal procedures and file a flight plan. Conduct a thorough preflight briefing among all flight participants and follow standard operating procedures and personal minimums.

For more information, pilots, mechanics and flight safety officers should visit the IHST website

@PilotSafetyOrg on Twitter: #PilotSafetyTip Commit to attending 1 [FAA safety] wings event and reading the @FAASafetyBrief every month.

@ChetBrandon1 on Twitter: Thanks for following me! As a pilot, and a safety professional, I appreciate the work you guys do!

@Blessed_Aviator on Twitter: Is that 704RC calling? Thinking about flying in the cold like I am? Be sure to read the latest edition of @FAASafetyBrief.

FAA Safety Briefing welcomes comments. We may edit letters for style and/or length. If we have more than one letter on a topic, we will select a representative letter to publish. Because of publishing schedule, responses may not appear for several issues. While we do not print anonymous letters, we will withhold names or send personal replies upon request.

If you have a concern with an immediate FAA operational issue, contact your local Flight Standards District Office or air traffic facility. Send letters to: Editor, FAA Safety Briefing, AFS-850, 55 M Street, SE, Washington, DC 20003-3522, or e-mail SafetyBriefing@faa.gov.



Let us hear from you — comments, suggestions, and questions: email SafetyBriefing@faa.gov or use a smartphone QR reader to go "VFR-direct" to our mailbox. You can also reach us on Twitter @FAASafetyBrief or on Facebook — [facebook.com/FAA](https://www.facebook.com/FAA).

(www.IHST.org) to read up on the many free reports, safety bulletins, and toolkits available to them. They also should equip themselves with tips and best practices encouraged by the FAA Safety Team (FAAST), Helicopter Association International (HAI), and the Helicopter Association of Canada (HAC).

Gene Trainor is a technical writer and editor for the Rotorcraft Directorate in Fort Worth. He previously worked as a newspaper reporter and editor.

Practical Performance

If you are in some way involved in flight training, you may have noticed that recent updates to the Airman Testing page (www.faa.gov/training_testing/testing/) on the FAA's website provide some important information. Among other things, it states that beginning February 9, 2015, types of questions eliminated from the private pilot airplane knowledge test include "aircraft performance and weather questions that involve multiple interpolations across multiple charts." I'll come back to this specific topic shortly.

Regular readers of *FAA Safety Briefing* may remember reading already about the agency's collaboration with aviation community experts on development of, and transition to, the integrated and holistic Airman Certification Standards (ACS) approach to airman certification. I won't repeat the details here — you can now find extensive ACS-related information on the Airman Testing web page — but the announced improvements are only the first of many ongoing updates and enhancements to airman knowledge testing.

The FAA is now applying industry's ACS-related tools and procedures to the review, revision and, eventually, the development of knowledge test questions.

The "Boarding" Process

While most people do tend to equate test-taking with waterboard-style unpleasanties, that's not what we mean when we talk nowadays about "boarding" questions. In keeping with both industry recommendations and best practices, the FAA has established a formal exam review board to improve its knowledge test question data bank. The board is comprised of subject matter experts from a range of FAA Flight Standards policy divisions, such as the Air Transportation Division, the Flight Technologies and Procedures Division, the Regulatory Support Division, and the General Aviation and Commercial Division. Consistent with industry best practices, the exam board also includes an "outside stakeholder" who has extensive qualifications in aviation, aviation training, and the overall test development and test management process.

The task is monumental, but the board members are ferociously dedicated to ensuring that

we make knowledge test questions accurate, up-to-date, educationally sound, and relevant to real-world operations in today's National Airspace System (NAS). We are using a range of tools and processes to achieve this objective. First, there is considerable real-world expertise on the board itself. Our members include air carrier, corporate, and general aviation pilots whose industry experience is recent. Second, the board is using a newly-developed and formally documented process for evaluating questions for educational and operational relevance. Third, we are using the ACS coding system (explained and illustrated on the Airman Testing web page) to ensure that each question links to a specific ACS Area of Operation/Task.

Performance-Related Results

On both the FAA and the industry sides, there are enormous amounts of "invisible" progress and activities underway in all aspects of the airman certification system. The announced changes to the private pilot airplane knowledge test are important not only on their own terms, but also as a visible marker of our collective commitment to improving the airman certification system. The deletion of performance questions "that involve multiple interpolations across multiple charts" is an excellent example of how the new exam review board has approached its task. Working together, board members quickly concluded something most of us have known for years: overly complicated performance calculations that yield impossible "precise" answers are, ironically, grossly inaccurate — not only in terms of real-world operations, but also in terms of safety. Decimal-point precision makes little sense on performance charts developed in carefully controlled conditions and by a professional test pilot's simulation of "average" pilot skills.

As I said, it's a monumental task, with thousands of questions still to be "boarded." But just as the journey of a thousand miles begins with a single step, the boarding of many thousand questions is now solidly underway.

Susan Parson (susan.parson@faa.gov, or @avi8rix for Twitter fans) is editor of FAA Safety Briefing. She is an active general aviation pilot and flight instructor.

In keeping with both industry recommendations and best practices, the FAA has established a formal exam review board to improve its knowledge test question data bank.

Pete Neff

Manager of the Long Beach Aircraft Evaluation Group



After 27,000 accident, incident, and violation free flight hours, Pete Neff wasn't ready to retire. He is now giving back to aviation as a public servant, leading one of FAA's five Aircraft Evaluation Groups (AEG).

Pete's love for aviation started at a young age, when he used to lie on the grass in his backyard to watch DC-3s fly overhead in Hartford, Conn. He also got to climb around a family friend's C-45 *Expeditor* (military version of the "Twin Beech" airplane) quite often at the local Army Reserve airfield. Later, as a senior in college and a ROTC cadet, Pete soloed on the very same airfield he played on as a kid. He completed Air Force pilot training in 1969 and flew more than 830 combat hours over Vietnam.

"I was fortunate enough to fly seven different types of military aircraft, to include the T-38, the C-130, and the C-141," notes Pete.

After completing his military service, Pete became an airline pilot and captained five different transport category aircraft. He holds type ratings on nine transport category aircraft to include the Airbus A380. In 2006, he joined the FAA as an aviation safety inspector (ASI) in the General Aviation and Commercial Division.

Now, Pete manages a team of operational specialists at the Long Beach Aircraft Evaluation Group. This team flies experimental and post-production new or modified aircraft to evaluate their operational suitability. The AEG evaluates the aircraft handling characteristics, the human factors workload of normal and abnormal cockpit duties, and the operational suitability of the installed avionics.

"Our evaluation determines the training, checking, and currency requirements a pilot must meet to be operational in an aircraft. Additionally, our evalu-

ation includes exploring the performance envelope of the aircraft and documenting special handling and performance characteristics in the Flight Standards Board Reports. We establish the pilot type rating for new aircraft and determine whether modified aircraft qualify to maintain the same pilot type rating. We also have a team of airworthiness/avionics experts who develop the on-wing maintenance procedures required to keep an aircraft in an airworthy condition."

Pete's team was also instrumental in the operational evaluation and eventual certification of the first two unmanned aircraft systems (UAS) certificated for commercial use. The team collaborated with the Los Angeles Aircraft Certification Office (LA ACO) to evaluate the operational risks. Along with the LA ACO team, team members prioritized the risks of the UAS operation and developed appropriate mitigations to assure safe operations. Pete also notes that this collaborative effort, which earned the team an Innovation Team Award from the FAA Administrator, represents a practical application of the three attributes FAA Flight Standards Service Director John Duncan describes in this issue's Jumpseat department: interdependency, critical thinking, and consistency.

Looking back on his experience in GA, military, and air carrier airplanes, Pete points out that knowledge of the performance section of the aircraft manual and the discipline to apply that knowledge to each and every flight is the sign of a serious student of flight.

"We should all be students and learn something new on every flight. Knowledge of the performance capabilities of an aircraft and the discipline to fly the aircraft within the design performance envelope is a core competency of flight safety that every pilot should follow on every flight."

Next for Pete and his team in the certification process are the new versions of the Bombardier *C-Series*, *Global Express*, and *Challenger*, and Gulfstream airplanes along with Japanese Mitsubishi and Chinese regional jets.

Paul Cianciolo is an assistant editor and the social media lead for FAA Safety Briefing. He is a U.S. Air Force veteran, and a rated aircrew member and search and rescue team leader with the Civil Air Patrol.



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